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THE REAL CURRENCY OF COMMERCE.

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HAVING been invited to contribute a paper to the series of admirable articles on the financial problem which have appeared in THE ENGINEERING MAGAZINE, it gives me pleasure to comply; but, in order to do so, present demands upon my time make it necessary to draw largely upon an address which I had the honor of delivering before the Bankers' Convention, at New Orleans, in the fall of 1891.

To those of my readers who are confused as to the nature and functions of real money, and who are fearful of the supremacy of gold, I would most strongly commend the two excellent articles upon the subject which have lately appeared in these pages,—namely, "The Unit of Value in All Trade," by Mr. Edward Atkinson, in August, and "A Scientific Analysis of Money," by Mr. Emil Schalk, in September. These gentlemen have given us such a lucid exposition of the conditions and reasons which make gold the one universal standard of all values that I am at a loss to see how any one, after reading them, can be longer confused upon the subject. And it is because they have thus made clear the essential characteristics of real money that I shall now confine myself to a consideration of the currency—paper money—with which we transact the business of each day.

Although money is the measure and numerator of value in every other form of property passing between men, it is itself actually present in but a small proportion of the interchanges that constitute the great movements of trade and commerce; and it becomes less and less relatively used as civilization advances. What is called buying and selling is to the greatest extent, not the purchase of things for actual money, but simply an exchange or barter of the money's worth of one thing for the money's worth of another thing, by means of paper instruments called *currency*. In whatever variety of method such instruments are used, they do not, like money itself, possess inherent value of their own, but they derive their entire power and significance from the property which they convey. In every transaction to which such papers refer, they declare in effect that they are not the money, but only the shadow of it, and that the substantial value each piece represents is somewhere else concurrently moving with it in the process of exchange, or going forward to market. For example, the interchange of goods and merchandise, passing between people in the United States, amounts to more than three hundred millions per day. Only about one-twentieth part of this is done by the presence or manipulation of money. Nineteen-twentieths consist of an exchange or barter of that amount of one kind of property for the same amount of another kind, in the endless variety of things put in motion by the necessities of social life, and transferred by instruments in writing or printing, upon valueless pieces of paper, giving evidence of each transaction, in terms of money. And the same is measurably true in the commerce of the whole world. Stripped of the mystery and ambiguity that hang around them, the paper instruments by which all this is effected are currency, because they make industrial products current in the channels of commerce. In whatever form used, they are nothing more than written orders from one owner of a commodity to deliver the same to another owner.

A bill of exchange is the typical currency of the world. It is an instrument that exchanges moving property. It does not say that money itself, but something of the money value named in it, is passing from man to man by its instrumentality. In every movement from its origin to its end, it carries vital things,—goods, wares, or merchandise. If not, it is false to its name and nature, has left a vacuum to be filled, and done that amount of damage to commerce, yet to be repaired.

Paper documents thus conveying property have various names and applications. None of them are money, any more than a deed of a house is the house itself; yet they all perform the same substantial office,—viz., that of promoting a convenient interchange of various products of industry, through the channels of trade and commerce. Bills of exchange, bills of lading, bank-checks, bank-notes, or certificates of deposit, and even telegraphic transfers, are all similarly used in conveying existing things from owner to owner. And if legitimately issued, the relative property can be found by search,—just as truly as real estate can be found through its deeds of conveyance,—to be actually existing, each article responsive to its respective piece of paper record. Otherwise the document so used is commercially a false one, and, by whatsoever authority emitted, it can only enter into the commercial exchanges to vitiate to that extent the entire volume. Loaded ships passing each other upon the ocean, with cargoes of reciprocal values ; railroad cars filled with merchandise, threading their way to and fro through the land ; vehicles of every kind, crowding along the streets of cities, towns, and villages ; toilers on foot or in fields, manufactories, and shops,—all who labor in any useful way expend and renew their native vitality by exchanging its results one with another, upon conditions measured and expressed upon such paper documents in terms of money ; while the money itself constitutes less than a tenth part of the aggregate sum of commodities or service so passing between them. The world has thus ever been alive with these movements of industry and toil. They belong to men as personal and responsible beings, independently of all governments. As government has no attribute or function whatever for productive labor, but is dependent for its very existence upon the labor of its people, neither can it legitimately furnish instruments that only rightly follow *after* production. Governments can directly draw from the real producers by taxation such portion of the fruits of their labor as can be spared for the national administration and protection ; but any attempt to forcibly impose its own paper instruments upon commerce, in advance of industrial productions of the country or without their accompanying supports, not only transcends all its legitimate powers and impairs the equitable relations of citizens with each other, but can only end in destroying the sources of its own vitality. There is no place in sound financial economy where a government, any more than a private citizen, can, with impunity, introduce into commerce a single item of paper currency not supported by its equivalent value of existing commodities, passing with and pledged to redeem it.

What is a bank but a depository, not so much of money, as of the money's worth of the variety of articles that its dealers are producing and interchanging through them, hour by hour? Their deposits, what are they? Not money, but so much money's worth of existing commodities continually changing and moving about in kaleidoscopic variety from one form, from one person, and from one bank to another? Every deposit brings to the bank some new commodity, and every check releases some one previously held. Their capital, what is it but a vested interest in the same convertible mass of stored industry? Their circulating notes, what are they, when properly issued, but more minute representations of the same substantial and exchangeable results of human service? And their bills receivable, they are nothing more nor less than chattel mortgages upon goods held in custody for them by their customers, who have promised in writing to surrender so much of their value as they have previously received. Each one and all of these functions of a bank are simply commercial expedients to facilitate the division and distribution of the miscellaneous productions of human labor. And the daily exchanges of checks between banks at the clearing-house? What are they but evidences of the industrial movements of the whole city the day before? Each check pointing to a box, bale, or bundle containing the commodity that gave it birth, and attesting the fact that by it some real thing, of the money value named, has passed from owner to owner, and from bank to bank, the validity of which is proved by the payment in actual money of balances resulting from the exchange of such checks. All these are but various ways of exchanging existing things, and are valid and admissible only to the degree that they are resolvable into other things of daily necessity.

The whole movement is one of property, not of money.

In fact the safest bank officers are those who keep the papers and the property most persistently together, and who hold them in the closest relation to each other.

International trade of the world is carried on from age to age in substantially the manner here described, by bills of lading and of exchange, conveying from port to port, and from citizen to citizen, the productions of the industry of their respective countries. These are divided and sub-divided through banks and bankers in New York, London, or elsewhere, as the interest and convenience of commerce require, and the desired result is reached by exactly the same natural methods of distribution. Commerce is but an exchange of material things. The instruments it uses are born in the things to be moved, and cannot be dissevered without impairing the utility of the entire system. "Their lines have gone out through all the earth, and their words to the ends of the world."

No government device or debt currency has ever been or can ever be, without intrusion, admitted into the international exchanges, and no want of it is ever felt. On the contrary, its introduction would be instinctively repelled by merchants and other governments the world over, as an invasion of natural rights, utterly discordant with legitimate trade, and adverse to every commercial interest. What is confessedly false in the commerce of the world at large must be equally so when applied to any one of its nationalities, or to the individuals composing it. Human law cannot change the essential nature of things.

As all valid currency is thus invariably found directly springing out of useful labor, so the want of it can only be supplied by more rigid economy in expenditures and by renewed effort in production. Thus only will it be produced in manner and measure to meet every social and commercial requirement, from the smallest trade to the largest commerce. It is not national currency that is wanted, but things to be exchanged. These can be produced only by human effort. Currency is a consequence, and will come of itself when the object of it exists. Any extrinsic emission which multiplies baseless instruments of expenditures can only serve to promote extravagance, by deceiving the public as to its real ability to expend, and thereby to repress all effective efforts at restoration.

Two important lessons may here be learned :

First. That no just estimate of the amount of currency required by a community can ever be made in advance of the industrial work done ; because the currency will naturally follow the product and provide means for its own distribution and conveyance, if government do not interpose its overwhelming power by injecting into it an abnormal and baseless issue, or by prohibiting the use of such instruments of transfer as commerce naturally creates for itself. That any calculation predicated upon a *per capita* ratio of currency to population is essentially and manifestly absurd, because, not the wishes, the poverty, or the number of people, but their productive industry alone, can determine what instruments of exchange are required, and who has the right to issue them.

Second. That currency derived from natural causes will come and go, and live and die, in exact coincidence with the volume of useful things to be moved by it, and will therefore, possess the quality of elasticity which attaches only to the genuine article, and which can never characterize a superimposed emission. This is the striking defect of our existing currency. It comes from an extrinsic source, not in response to commercial demand, and will not retire when its special service is performed. Immediately upon its emission, it becomes inseparably absorbed in the previously existing volume and there remains, irrespective of times and seasons and of commercial necessity. From first to last it is a debt, without corresponding assets in store waiting to redeem it ; an outside and disturbing element, without homogeneous relations to the trade it is meant to promote. Its constant tendency is to create and to maintain fictitious prices, and thus to counteract the harmonious precision that the movements of commerce naturally make for themselves. A credit currency without full and convertible security can never give substantial relief. It will always be insufficient to meet the demand, because it inflates in expectation of further issues, and, when these are once entered upon, the solid commercial principle is thereby avowedly relinquished and the stability of prices is consequently destroyed.

For illustration, follow for a moment the movement of a single staple crop. How could that be best carried from harvest to market? Those who take it from the ground have in hand the vital thing that the world requires. At the very start, the producers desire to subdivide it in such manner that it will itself furnish means to pay for the labor and expenses of gathering the harvest. This they should be able to do by pledging the crop to responsible persons competent to accept it, who could immediately issue against it, at the place of departure, an approximate amount of circulating notes, evidences of possession, with means of redemption. These would be local currency, receivable throughout that community, at their money's worth, for such other things as the holder and laborers found necessary to purchase. The crop would then be transported toward the sea, either for consumption or for re-shipment, by means of larger bills of exchange, and the proceeds of it carried back, either in money or in other commodities, to the place of departure. These would there be distributed through the ordinary avenues of local trade, and be paid for in the currency first issued, which meanwhile would have served its purpose for local expenditures and been returned to its issuers for payment.

So the circle of exchanges would have been completed, the crop have done its good work in the world, and both the larger and the smaller instruments by which it was accomplished all retired from service. This service, so essential and so beneficent, has in the past been thus naturally done, year after year. It was freely relinquished when demanded by the supposed necessities for civil war, because the life of the government itself was at stake, and because commercial laws were necessarily subservient to the preservation of the nation. In the agony of the civil conflict, and when legal tender notes without security had been issued to the utmost practicable extent, Secretary Chase conceived the idea of replenishing the exhausted treasury by further sales of government bonds, giving banks specially organized under a law "*to provide a national currency*" the *exclusive* privilege of issuing currency notes based upon interest-bearing bonds of the government as security at 90 per cent., and prohibiting every form of circulating notes in the country by a penalty of *10 per cent.* upon any note otherwise emitted. But the impression now unconsciously prevails that what was then *precipitately done as a temporary expedient* was the result of deliberate and unconstrained legislation; and that, therefore, every form of local currency has been finally and forever superseded. This conclusion cannot be reached without ignoring both our own experience and the experience of men throughout the civilized world, nor without inestimable loss to commerce and to the nation. With equal reason may bills of exchange of larger denominations, by which whole crops are carried to market, be prohibited, as the smaller and no less useful ones, by which they are first gathered in, sub-divided, and started upon their course. By this prohibition of currency the annual commercial movement is obstructed at the vital point of departure. This fact is emphatically expressed by the cry periodically and vainly made for "currency to move the crop," when the crop contains the inherent power to move itself; a power which cannot be used because this legal restriction continues in force. So that as often as the harvest season comes around, it is found that government currency is so fully absorbed in the general circulating medium that it cannot be released and gathered up to meet this indispensable local requirement, without producing such financial embarrassment as retards the very movements of the crops themselves. A practical difficulty consists of the doubt whether any form of local or corporate indebtedness, like government bonds, can always command absolute sale in the markets of the world. And so the conflict between universal commerce and local currency annually finds repeated demonstration and expression in our own experience and observation, from the want of elasticity and flexibility in the circulating medium. To some extent this want has been supplied by the increase of small national banks organized throughout the country, by which local exchanges of commodities are pivoted from one dealer to another, as in the country store, by means of deposits and checks ; but they do not fully meet the commercial requirement, and the unceasing demand for currency remains to be provided. Besides all this, the "National Currency Act," the name under which United States government banks were organized, and which expressed the original object of their creation, is practically passing away by the redemption of the public debt. Something must be done to meet this imperative necessity and earnest demand.

It will certainly be found easier to legally restrict commercial instruments within the bounds of their constituent property when emitted by corporations, under the supervision of jealous government authority, than it is to restrain excessive issues by a popular government, when it has once assumed as its inherent privilege and prerogative the power to create currency without security at its own convenience, independent of all natural relations to the commercial basis and demand. If it endangers the public safety and is therefore criminal for any one man to issue a currency obligation without an equivalent asset, is it essentially less so when organized numbers clothed with delegated authority do it without reserve?

In every form of negotiable obligations their prompt redemption is the vital object to be secured. This can be best done by authority given to corporations under national authority to issue registered circulating notes based upon commercial assets, with limitations of amount proportioned to capital engaged. With these requirements and a penalty of an extra rate of interest upon notes while in default, an enforced redemption, and making the notes a preferred debt, with mutual liability of all who participate in them throughout the entire system, and a safety fund in reserve, a practical and substantial currency could be established. By these restrictions every participating member would become a vigilant guardian over the whole body, the interests of commerce would be promoted, and perfect safety assured.

No government currency can possibly be made, in the very nature of things, combining all these requisites of elasticity, commercial stability, and guarantees of public welfare.

While paper currency instruments, as we have shown, perform so large a share of the vital work in the commercial world, money itself has in no respect lost its practical importance. On the contrary, to maintain commercial order and integrity, it can neither be dispensed with nor degraded from its supreme rank and importance by any local devices or substitutes, without infinite peril. Its universality, utility, and uniform character must not only be persistently maintained by every commercial people, but enough of it must be always held at command to meet and justify the claim for value of commodities passing through their commercial exchanges. Money must be ever ready to present itself as the only alternative, whenever its equivalent in property is challenged. It stands forth the ultimate arbiter of all commercial questions and values. Enough of it must be available and in close alliance with current business to meet balances between peoples, places, and nations to prove the validity of their trade; to meet unexpected events and vicissitudes in public and private affairs, or any exigency impairing commercial confidence; enough in a word to assure the public that it is enough. Deprived of these high qualities and practical uses, money loses its supremacy as a measure of value, and sinks into merchandise, subject to all its fluctuations and reverses.

It is but twenty years since Germany, in re-organizing her current coins so as to give emphatic expression to the existence of a new nationality, determined to place herself upon full equality with England, who was supposed to derive some commercial benefit by alone adhering to a gold standard. This great change by a great and victorious nation overwhelmed other European powers, and constrained them one after another to close their mints to silver coinage. Silver therefore no longer commands the same unquestioned right as before to be money in international payments, and, excepting for subsidiary coins and as a local medium, it is already reduced in the western nations to the condition of a commercial commodity.

It was perfectly natural that our country, the largest producer of silver, should contend with all its might against the abandonment anywhere, and especially at home, of coined money composed of our own ancient and familiar metal. And because Congress had given vitality and money power during the war even to irredeemable paper, it was plausibly urged that it had unquestionable right to maintain the coined "dollar of the fathers" at its full original worth against all the powers of the world.

But the diminished use of silver throughout Europe had so reduced its value below the ancient standard that these patriotic dollars were no longer serviceable as a money reserve for international payments; and they became even less important than a mere commodity, because the difference between their legal and their actual value prevented their being readily converted into other merchandise that would pay foreign debts through commercial interchange.

We are therefore no more masters of the situation in respect to the mineral composing money than to any other of the products of the country. The outside demand will determine the real value of them all, and to establish a local price of any thing by law can only create a vexatious impediment to its easy and equitable commercial solution.

The only rational treatment of this one commodity is to let it naturally pass into the channels of commerce and take its chances with other productions of industry, there to exert its own influence with the powers of the world who must unite with us in deciding whether it shall hereafter be an ingredient of commercial money or not.

Since silver coinage was placed upon trial for life in Europe, the amount buried in the United States government treasury has swelled by the silent operation of law to nearly $500,000,000, besides more than $100,000,000 held in personal and corporate reserves. This great and growing aggregate stands before the world a menace of vast proportions, depressing the price and retarding the metallic re-union so much desired. *What is to be done with it?*

The certificates and notes representing it are not naturally redeemed like bills of exchange, by conversion of the constituent property through the exchanges of commerce. It lies as dead and as useless as when in undiscovered mines, while *they* continually go the rounds as local currency, never themselves paid, but ceaselessly moving in current payments through the community, and increasing faster in volume than in intrinsic value. They raise the prices of property above the commercial standard, encourage expenditures, and create an adverse balance of international trade, which can be paid only in gold. This is the natural and undeviating law of such issues. Shall *this go on forever*, and *what is the inevitable result?*

LACK OF ORIGINALITY IN ARCHITECTURE.

By Russell Sturgis.

THERE has been great annoyance to the lovers of architecture from the recent instances of copying on a large scale. The mockers have mocked : but the citizens who are hoping against hope for signs of life in our fine-art of building have been scandalized in the literal sense of the word. It has been a trouble to many that, in our recent American architecture, a whole building, or a large and showy member of a building, should have been so closely copied from some fine old structure in Europe that it is easy of recognition. But those who are greatly exercised about this should not need to be told that such close copying has long been the rule in details. For what purpose are used those large photographs of small details of which every architect has as many as he can afford ? Are they supposed to be for artistical stimulus only and the free converse of the modern designer's mind with the great designs of the past ? There may be some offices where this is indeed their chief use. But one need hardly fear contradiction in saying that in the majority of cases they are used for simple copying. Either the photograph is handed to the draughtsman with instructions to rearrange the scrolls—a Renaissance panel of scroll-work being assumed—so that that design which was made for a surface twice as broad as high will fit one a little more nearly square ; or to alter the leafage around the cartouche—a Louis XV. pier-ornament being assumed—so that they will not cost so much to cut ; or to make the capital thicker at the neck-molding—a Gothic column being assumed—so that it will better fit the modern Romanesque style of the porch ; either this, or else the photograph is simply handed to the stone-carver with orders to carve two like that and two differing slightly, so ! and so !

Mr. Hamerton says of the French nobles before the revolution that the compulsory and unpaid labor of the peasants was regarded by them as a natural force to be made the most of, like wind or a stream of water. Ericsson's invention of the screw-propeller and Whitney's cotton-gin were simply appropriated by the public without reward to the inventors. In like manner, the fine decorative work of our predecessors in the artistic life is considered common property. No man need be ashamed or need hesitate to make the carvings and the inlayings and the paintings of the past his own so far as their spirit and their individuality is concerned. It is not many days since one of the more artistic, and also one of the most successful of the younger New York architects, hearing the complaints of a more naïf critic in a case of very visible "conveying," said very naturally and simply that he thought that none of the architects now expected to get up new designs for ornament; that all simply took what they wanted. It is not many months since one of our leading artists in decoration, setting his draughtsman to copying, not photographs, but the simple, cheap, and widely-known prints of *Art pour Tous*, said, half to himself, that there was nothing new under the sun; the inference being that he thought it better to do his taking openly than to make believe invent.

It is not asserted here that this habit is quite so universal as the architect cited above seemed to think. It is not asserted that there is any moral wrong done. What is asserted is that there has been for many years a deliberate taking of ancient details of all sorts and a fitting of them into modern buildings with greater or less skill; and that no one ought to be surprised at the growth of the habit into the taking of whole towers, whole gable-ends, whole edifices. In fact there is surprise in this case merely because few persons know the carved, the inlaid, and the painted ornaments, while many know the general aspect of a famous old building in a famous European city.

"But, morally wrong or not, artistically this is a very dreadful state of things! What is the remedy?" There is no remedy. The architects will give their clients what their clients will consent to receive. Their clients ask for a certain spirit, a certain comeliness, a certain approach to beauty in the resulting structure, but what client ever asked for originality? The architects will give their clients what their clients will consent to receive, because architects are not artists in the usual sense, but professional advisers; because the business of the architect is grown to be a great fiduciary, money-spending, administering profession, liberally paid, as all money-spending and administering professions will always be. A painter, even a painter who loves money and lives with rich people, will not, knowingly, sacrifice his pictures to his purse. If he does, his fall is rapid, and his place as an artist knows him no more. A painter's art is much to him, is almost everything to him, even if it is but a poor little staggering art that he is master of. But an architect need not have any such devotion to any form or fashion of fine art. An architect is employed to spend, judiciously and wisely, perhaps a million dollars a year of other people's money in the erection of important and permanent structures; skilfully planned, carefully built, money-making structures. In doing this he earns a very handsome income; and this he earns, not as an artist, but as an organizer and director of labor, and the payer-out of large sums of money. If he is an artist, or if he cares to use the services of artists, that is secondary. If he thinks his employers, generally, want something artistic, or that he will be more largely employed by offering something artistic, well and good! He will give his clients what they will consent to receive. But this fact must never be lost sight of,—that it is a terrible expense to him to have to furnish something artistic; and that to select it ready made, if it is positively called for, is the simplest and easiest way, and saves him very heavy outlay.

For what is it that determines an architect's compensation? The amount of the money expended on the building. And what is it that makes up the greater part of an architect's expenses, and determines the outgoes which must be subtracted from the income? The employment of high-paid draughtsmen. And what is the most precious and the rarest commodity of all in a busy office? The architect's own time. Now then! to allow a good draughtsman, earning seven dollars a day, to spend a week elaborating a fine original design for a panel, which design will not be any better abstractly, as a separate work of art, than one of which a good photograph is at hand,—to allow such extravagance as that would be a poor sort of "business." Still less would it be business-like for the pressed and busy architect himself to spend his time over the design; indeed, he could never do it; the man who has to meet employers and contractors all day, and fly off on a superintending trip, by rail, before night, and dine *en route*, or in strange hotels on his arrival, is not in the mood of mind to be a fine designer. Designing requires a calm and receptive mind, neither fatigued nor asleep for want of occupation; designing requires some consecutiveness of thought and must not be broken in upon every few moments. Designing of ornament for a building requires a large knowledge of the building, its requirements, its possibilities, of what it is to be as a whole; and therefore the designer must be well up the ladder, a high-paid and confidential assistant, if not the chief himself. But designing done according to all these principles, and up to the mark of fitness, of merit, and of originality, will not pay. How should it pay? The architect's commission will not be increased one dollar by all the beauty and novelty presumable in his original design. If his panel costs more to carve than the conveyed one would have cost, he will get a larger commission by that fact, but he will disaffect his client. If his panel costs less? Well, if he must make a panel to cost less, and by so doing cut his commission down; if this cannot be avoided,—let him at least not take the trouble of making a new design under such untoward circumstances as these!

These considerations apply especially to decorative sculpture and other ornamental detail, but there is a way in which they apply as well to the general design of buildings. Let it be clearly understood that time must not be spent, unduly, upon the plans, and the whole situation explains itself. Here is a set of drawings under way; considerations arise which seem to call for several days' careful thought over possible modifications, and a week's work in altering the drawings,—the five or six ground-plans, the four elevations, the two sections, the two or three partial sections, the diagrams of flues and of drainage. But a week's extra work on the drawings means perhaps two hundred dollars sunk in the pay-roll alone. But three days' careful thought on the part of the chief himself means something that he can't possibly give just now! If the stairways and halls must be changed, let the draughtsman in charge of the job alter the plans as best he can, but at all events avoid any changes in the exterior! And the chief, who alone has been instructed by the owner as to the new requirements, it may be, having given his orders to his assistant, flies out of town by the fast train, busily annotating a specification as the train bears him onward, or even laying out the plan of some newly proposed structure. The result is, even in costly, elegant, and much admired buildings, a mass of anomalies: dark halls which might have had window light if thought had been given to them; stairs of undue steepness; halls with insufficient access and exit; and, most of all, a lack of thoughtful designing in the interiors such as must be experienced and carefully noted in many buildings before the extent and generality of the evil can be appreciated. This, indeed, is the crying fault of our late nineteenth century buildings,—a lack of any intelligent artistical treatment within. The façade may be elaborated, but, once past the entrance doorway, and all signs of care vanish together, and it appears that only the most elementary planning has been given to the rooms and corridors, stairs and lobbies. The owner and employer helps toward this neglect because he fancies that he understands the plans, and, having once approved them, thinks of them no more. But not one employer in a hundred, be it a committee, or be he a bank president or a family man proposing a family house, really understands the plans. That the fireplace is to be in such a wall, the windows facing in such a direction and the door to the hall in such a corner he knows, but what will be the effect, in convenience or in architectural comeliness, of these dispositions he does not know at all. So, while he prides himself on the minuteness of his directions and the thoroughness of his supervision in even the smallest details, the large considerations of the organization and harmony of his interior pass him, almost wholly unthought of. The owner cannot see the future structure ; it is the architect who must see it if it is to come into existence as it is wanted, and he seldom has the time to see it clearly, or to look at it in his mind's eye, long enough to recognize all its features.

Originality of design is more easily got for the general masses than for the details, because the necessary accommodations of the house positively command an outline and a grouping which cannot be taken ready-made from an ancient structure. But this originality is not especially tempting to the designer himself or to the spectator : not to the designer himself, because he does not and thinks he cannot take time enough to work his design out into harmony and completeness ; not to the looker-on, who finds the new structure odd enough, and novel enough, but noways charming. And therefore, when the chance offers of taking an ancient and beautiful building and copying it ; when that *can* be done,—the architect may well feel a certain relief in the beautiful, thoughtful, purposeful work which his draughtsmen are copying, and the student of the finished building may well be pleased and soothed,—until somebody tells him that this is a copy, and then he complains aloud.

Originality in architectural design is not for him who seeks it eagerly for its own sake ; it is for him who considers his problem patiently, for days or for moments only, until the right inspiration comes to him. Neither the faithful following of a well-known style nor the rejection and disregard of all established styles can help very much in the search for originality : nor yet can either such acceptance or such rejection seriously hinder. A designer may be tied down to a style as closely as was Burges at Cardiff Castle, or Viollet-le-Duc at Pierrefonds,—tied hand and foot to tradition,—and yet may be original. A designer may disregard all known styles of architecture as freely as he who builds a log-cabin in the woods, and yet may show an absence of all power of original design. And the lack of originality visible in our American work of these latter days is not caused by the absence of any accepted style in which all may work, though to have one would help us : it is not caused by any unusual rarity of the artistical gift, there is a great deal of that, running to waste : it comes simply of want of thought. It does not pay to give time and thought ; it does not hurt the architect much *not* to give time and thought, that is, to his design ; and therefore thought is not given, time is not allowed, prompt decision, business-like despatch are the qualities desired in an architect's office as in a mercantile house ; and the plans are made, the specifications written, the contracts drawn up, the superintendence followed up,—all according to the most approved business habits of the day. Design, alone, must needs suffer ; and originality, as the true essence of design, must needs remain unregarded.

PRACTICAL MACHINE-SHOP INSTRUCTION IN TECHNICAL SCHOOLS.

By Prof. Joseph Torrey.

IN any discussion of technical-school instruction it must be treated as an existing, and not an imminent thing. It is out of the pioneer stage, and more or less independent of criticism. In fact, barring seniority, which is not a very lucrative possession, the technical schools have, all round, rather the best of the colleges. Any one who studies their history in this country will be greatly impressed with the high ideals and broad wisdom of the men who were instrumental in evolving them, and yet, if he has been a careful student of human history, he will say to himself that institutions have not always been able to carry out the purposes of their founders, and he will naturally inquire how far the ideals of the founders are being realized in the modern technical school.

In most modern systems of technical education the machine-shop holds a prominent place. What is its object? Is it intended to furnish a species of apprenticeship from which boys shall emerge machinists, or is it simply a laboratory and amenable to the same limitations and laws as any other educational instrument?

At the very outset we shall find that the answers to the foregoing questions depend largely on what answers we give to another similar set, involving the aims and objects of those who attend these schools, and the results of the training they gain there as shown by their after experience. These questions we can answer in a general way quite readily. The greater part of those who enter the technical schools are comparatively young students with often only a scanty equipment of fundamental knowledge. They enter on a technical course of training with a view to utilizing that training afterwards as a means of livelihood. Very few of them mean to be machinists, molders, engineers, carpenters, or mechanics of any kind. Many of them aspire to positions of responsibility and trust in manufacturing establishments, and by coming to the technical schools instead of serving an apprenticeship in the works they virtually pronounce it their opinion that, all things considered, this is the better and surer course to take.

If this is a fair statement of the case,—and I think it will be generally accepted as such,—we should expect to find the technical schools planning their work and adjusting their equipment to meet the requirements of such a class of students as has been sketched. Educational institutions are molded not by trustees or founders in most cases, but by students. If then we enter upon any discussion of the methods and appliances of the school shops, it is clear that we must consider them from this point of view,—not as training schools for mechanics, but as having in view the development of men more particularly fitted to deal with wholes rather than with their parts. The question is then : Are the methods and appliances of the school shop adequate to the task of producing men capable of taking important positions without considerable supplementary experience in the works ? First of all we must inquire, what are the qualities which such a position demands in him who holds it ?

To begin, he must have a certain just and well-earned independence—or better, freedom—of thought and judgment. In the second place, he must be far-sighted, able to see over the heads of his men, planning far in advance such changes as will be necessary to meet the demands of the times, always watching tendencies and not the mere order of events. He need not be an especially skilful mechanic himself, but, if he can add this to the foregoing qualities, it will certainly increase his efficiency. Finally, he must command the respect and regard of those under him, and have the power to make them enter into his ideas and work out his plans. Such, broadly speaking, are the qualities which must characterize a man who holds any responsible position in a manufacturing establishment. Now let us analyze these requirements, see how they may be attained, and judge, as well as we can, whether the technical-school shops are likely to furnish the requisite conditions.

Independence of thought and judgment usually comes from two things,—experience and much thinking. Neither one alone can bring it about. The same is true, only perhaps in a higher degree, of far-sightedness. The other essential qualities mentioned are, I think it will be conceded, largely matters of temperament and disposition.

How much, now, can the technical school do toward equipping a man with such qualities ? Can it, in the first place, give experience ? If so, to what extent ? This question has been discussed over and over again. The very best engineers in America have devoted special sessions of their meetings to it, but I cannot find that it has been seriously maintained that the amount of work done by a student in the shops of a technical school can be taken as so much practical experience. The time is too short, the view too limited, and moreover there is lacking in most cases the reality of actual shop-work. The most serious obstacle, indeed, to the successful employment of the school shop as a means of actual practical experience is found not in the shop itself, though it has its limitations here, but in the student and in the atmosphere of student life. We may talk, if we please, about the earnestness of students, and may fancy, if we see fit, that we find more of this desirable element in the technical school than in the college, but as a matter of fact every year sees less and less difference between the institutions in this respect. In both of them conditions have changed considerably within the last ten years. The life of the student is more complex now than it formerly was, and the element of *study* is only one among a number, all of which demand some attention. As a whole the change has probably been a beneficial one, but we certainly have been obliged to forfeit something. Then again the very largely increased number of students, which is such a perplexing element in the educational problem to-day, has tended, as it must necessarily do, to make classes more unwieldy and work of all kinds more mechanical. Nor can it be truly said that the laboratory and laboratory instruction have escaped this. Every one who is connected with such instruction knows that most students regard the work simply as a set of things to be done, and in the doing of which they must attain a certain degree of accuracy. The question that the teacher hears most of in the laboratory and that depresses him most is "Will this do?" or "Is this good enough?" The mischief is often done, moreover, before the man gets to the college or the technical school. Their influence and traditions reach far back, to the boy in the grammar school, and in most cases when he comes to college or to his special school, whatever it be, he is entirely *au fait* and settles into the harness immediately with a pretty good understanding of what will be required of him, and how he can meet requirements most easily.

To some extent, then, we must take this matter into consideration. A young man working at his bench in the machine-shop of a school is a *student* and lives the life and thinks the thoughts of a student. Put the same man at work where he can barely earn a living and where a mistake means so much spoiled material and wasted time and may cause him to be put back, and he is obliged to labor in a very different way. It is one thing to stand over a steam-engine, take a few cards, adjust a valve, set an eccentric, or scrape a bearing in the engine-room of the technical school, and quite another thing to stand over a fast engine driving machinery which *must not* stop and which has obligingly taken the opportunity to develop a hot crank-pin or a broken piston-ring. The mere agony of soul of such an hour calls out a man's resources as never before.

It is hardly possible to emphasize this point too strongly. The difference is not so much in the things done as in the attitude and standpoint of the man himself. If we undertake to criticise the equipment of the school shop and the plan of work therein carried out as if the fault were to be found there, we shall find our task a very difficult one. The tools and machines are in most cases excellent. If any criticism at all were to be made, perhaps the most just one would be that the machines and tools are a little too good. It certainly is a matter of experience that the best kind of apparatus for a beginner to work with is such as makes success depend, in the main, upon his own judgment and skill in handling it. The best training in measurement is afforded by comparatively rough instruments, stress being laid mainly on the point that with instruments of a certain degree of correctness we can reach a result of a certain order of accuracy. By studying carefully the conditions we can perhaps improve our first results a little : but ultimately we reach a well-defined limit which can be passed only by using better instruments. If this step be taken, and the possibilities and limitations of the problem be studied anew in the light of the increased field of errors introduced by changing to more delicate instruments, we can attain to a result which will be of a higher order of accuracy than the first one. I believe this principle could be applied with great advantage in some lines, at least, of shop-work. I have many times noticed in graduates of technical schools a tendency to use instruments in an unintelligent way. For instance, I have seen indicator-cards figured to the $\frac{1}{1000}$ of a horse-power when the reducing gear was very loose on centers and the cylinder had not been measured. I have seen measurements made with a wooden ruler graduated to $\frac{1}{16}''$ recorded to hundredths of an inch. I have seen the weight of cast-iron pieces calculated to the thousandth part of a pound with no real knowledge of conditions which would warrant such exactness of statement. Such performances are not by any means uncommon. One of the rarest sights to be seen in any kind of laboratory, mechanical or otherwise, is a student whose work is *consistent* throughout, and who has the judgment to carry his measurements to a point indicated not by the limit of the graduation on the scale, but by his own clear perception of the conditions, requirements, and possibilities of the case.

I believe that a student will make better progress in this direction with rather rough instruments, but much can be done toward cultivating the corresponding habit of mind, no matter what kind of instruments are employed. So also with machine-work. It is not so important that a young man come from his shop training able to make a good fit, as it is that he be able to rightly estimate the real accuracy of his work. Let him be taught that he is not to ask his instructor whether the work is "close enough." He is to know for himself just how close it is, and just how well it meets the requirements of the case.

Students differ very widely in this respect. Some need only a hint, and never lose sight of the idea, which fits perfectly into their natural ways of doing things. Others learn only in a sort of automatic way, and never work with any freedom. It is vain to expect anything different. The engineering sense is, to a great extent, born in a man. If it is there, it will permeate any kind of a course of training whether taken at the apprentice's bench or in the shop of the technical school. If it is not there, no amount of training can *create* it. Some men who have had all the advantages of both school and shop experience seem never able to grasp firmly fundamental principles. One designs his first machine without any due appreciation of the fact that strength is good only when it is in the right place,—when it is actually opposed as a resistance to deflecting or distorting forces. Another, carried away by his interest in designing a certain piece, or carrying out a certain idea, emasculates his work by too much detail and wastes time and material on something which, when completed, is only a blunder. Or there is a failure, through short-sightedness, to provide for all the requirements. I recently saw a newly-designed tram locomotive in which the generally desirable quality of rigidity had been carried so far that the machine refused to go round a curve. Such mistakes as these do not always come from a lack of what I have called the engineering sense. Quite frequently they simply indicate the lack of a kind of experience which is only obtained by close and living contact with actual conditions as they are found in practice.

It is clear now, I think, that most of the qualities necessary to a man who is to take a responsible part in mechanical matters are such as belong to a somewhat mature mind. In most cases time and experience only will bring such maturity, but certain it is that the school, and particularly the school shop, can bear a very important part, not only by supplying elementary knowledge, but by inducing in the student habits of mind which will follow him into active life. This, it seems to me, is the natural function of the technical school. While a man remains a student, he thinks and works as a student. He is impressed mainly with the multitude of facts surrounding him. He deals largely with books and thinks in book form. He has little experience to go on and so lives largely in the experience of others. All this is well if only his eye penetrates behind the practice and grasps the principle. Sometimes this is the case, but not generally. Whatever else may be said of the atmosphere of the modern technical school, it is not a reflective one.

Just here the influence of the teacher cannot be too strongly emphasized. If he is himself a practical man in the true sense, possessed of a clear head and of creative energy, one who has been accustomed to deal with facts at first hand, he can, if he has the spirit of a true teacher, impart to his students something of his own mental stamp, so that they too will think for themselves, and all their work will show the freshness of *real* originality. It has always seemed to me, moreover, that the students might profitably be thrown on their own resources more than is generally the case. Of course the chief obstacle to doing this lies in the effort to get a class over a certain amount—generally a considerable amount—of ground in a given time. It is just this effort that should be especially deplored as fatal to the attempt to turn out clear and independent thinkers. It is neither in amount of work done nor in multitude or completeness of appliances, but in the molding and enlarging influence of an inspiring teacher that the chief possibility of the technical school is to be found.

To sum up: the technical school furnishes, in its machine-shop, a laboratory, not an apprenticeship. Its constituents are students and its atmosphere that of a school. The instruction offered is, so far as courses and appliances are concerned, about as "practical" as it can be, and it should be of great value as a preparation for all grades of mechanical and technical work; but in precisely those points which are most indispensable to the training of a thorough mechanic, or indeed to any person who is to take a responsible position in mechanical matters, it is deficient. From this statement of the case we should be led to expect what experience confirms,—namely, that in a considerable majority of cases the technical school graduate needs a supplementary apprenticeship before he is fit to take the position of foreman or superintendent. There are exceptions, of course. I have myself known one or two such cases.

Finally, any one looking over the problem of technical training, and inquiring how its work must be planned so as to do for a young man the most possible in a given time, can see many things that would be desirable if practicable. For instance, it would be desirable if students could come with more of a good foundation of general education under them. We in the colleges echo the wish, but it sometimes seems as if every tendency were in the opposite direction. It would be a great step in advance if men would come to the higher schools mature enough to know what they can do and what they want to do. Then if instructors could only tell certain students that they have no business in a technical school and never will have,—not roughly but kindly,—and give them some advice as to what they had better do; if, in short, there could be more *selection*, and the numbers to be handled reduced somewhat,—everything could be done better. As things are now constituted and now tending, it does not seem as if much could be done in any of the above directions. How much difference it would make in the situation if the technical schools really tried to be *selective* is a question. The experiment is certainly impracticable under existing conditions, but one can hardly help wishing it could be tried. One thing is certain: minds cannot be trained by machinery, and in general, as our educational institutions become more crowded, instruction will certainly become and is now becoming more and more machine-like. If the time ever comes when the colleges and technical schools are less crowded, and when more men stop with an ordinarily good high school education,—a state of things which would have its advantages,—there is no doubt but more will be accomplished in the line of making thinkers in both technical school and college. Either this must be the case, or evolution must work some change in the coming student, by virtue of which he will be led to reflect and think under conditions not favorable to the student of to-day.

THE ART AND DEVELOPMENT OF TOPOGRAPHIC MAPPING.

By Arthur Winslow.

TOPOGRAPHY is a word which means, strictly speaking, a description of a place or tract of country, relating to its natural or to its artificial features, or to both. Correspondingly, topographic maps have been made to include a great variety of objects, natural and cultural. Nowadays, however, the distinctive feature of a topographic map, as commonly conceived, is the representation of features of relief, and such a map is more exactly designated, perhaps, as an orographic or hypsometric map.

The construction of maps dates from the dawn of history. A papyrus in the Turin museum has been identified as the topographic map of a gold-mine in Nubia constructed prior to 1500 B. C. Anaximander of Miletus (634-546 B. C.) is credited among the Greeks with having made the first maps. Parmenides of Elea (460 B. C.) demonstrated that the earth was a globe, and in the years following a real advance in cartography was made. Ptolemy's historic atlas was prepared about 150 B. C., and in the succeeding centuries the production of maps of greater or less worth was comparatively common.

The importance of maps for administrative and war purposes was early appreciated by many governments, and national maps of varying character were constructed at early dates. Of the kingdom of Wurtemberg in Germany, an unpublished map was prepared as early as 1452. Maps of Bavaria prepared early in the sixteenth century were used for 200 years. The earliest known atlas of Austria is from eleven wood-cuts dated 1561. The first map of Russia, made about 1550, and known as "The Great Drawing," has been lost. Printed maps were prepared a little later. Peter the Great, appreciating the importance of maps, ordered the execution of surveys and the preparation of maps as early as 1720.

The earlier maps attempted generally only a representation of the outlines of continents and seas, the delineation of great rivers, the tracing of national or tribal boundaries, and the location of large cities. Many compilations were, however, also covered with fantastic figures and designs illustrating the population, fauna, and resources of distant lands. In some cases rude attempts were made to show mountain systems, in which attempts we may recognize the embryonic desire to portray the relief of the earth's surface. Indeed, as far back as the old Turin papyrus there is a weak effort to picture mountain chains. On other later maps we find small mound-like designs, or rough angular dashes drawn in succession to indicate mountains, and, as we pass on from these, we find these additions growing in art and accuracy. On maps of the eighteenth century and the early part of the nineteenth infinite labor in draughting was often applied to cover the surface of the map with such conventions, which, though often expressing much detail and of excellent artistic effect, yet conveyed only general ideas of distribution and little or nothing of the relative magnitude and true shape of elevations. On a map of the Breisgau published by Homann in 1718, according to Ravenstein, is what is considered the first noteworthy attempt to represent elevations, as seen from a bird's-eye view, and of shading them according to the steepness of slope. This became soon more fully developed, and was popularized later by Arrowsmith. Here, however, everything was left to the judgment of the draughtsman, and not until Lehman, in 1783, had proportioned the strength of the hachuring to the steepness of slope, and virtually introduced a series of contour lines, was exactness possible. In 1737 Philip Buache prepared a contour map of the British channel and suggested the application of the system to land surfaces. It was soon after put in practice in France, which has the credit of having first undertaken a scientific topographic survey, about 1744.* England followed close on the footsteps of France. The first work here was a systematic survey of the Scottish highlands, begun in 1747, and a general trigonometric survey was ordered in 1791. Other European countries soon engaged in like work, and the present century has been one of great activity in this direction. At present almost the whole of Europe has been mapped in great detail, and considerable parts of North America, Asia, and Africa. The accompanying table, extracted from Mr. J. G. Bartholomew's valuable article on "The Mapping of the World," published in the *Scottish Geographical Magazine* of June, 1890, shows the distribution of this work :

*Later the production of topographic maps was much encouraged and develcped through the influence of Napoleon I.

TABLE SHOWING THE EXTENT OF DETAILED TOPOGRAPHICAL SURVEYS.

Continental Divisions.	Area in square Miles.	Area Undergoing Survey.	Area not Undergoing Survey.	Remarks.
Europe	3,757,000	3,413,000	344,000	All except Turkey, Bulgaria, and Luxemburg.
Asia	17,213,000	2,368,000	14,845,000	Only India, Java, and part of Japan.
Africa	11,515,000	280,000	11,235,000	Only Algeria, Tunis, and Eygpt.
North America	7,900,000	2,000,000	5,900,000	Geological Surveys of the U. S. and Canada in progress.
South America	6,855,000	......	6,855,000	No Detailed Surveys.
Australasia	3,200,000	......	3,200,000	"
Polar regions	2,000,000	......	2,000,000	Unexplored.
Totals	52,440,000	8,061,000	44,379,000	

The construction of maps has grown out of the desire to convey graphically a mental picture of geographic facts and to preserve this picture for use and record. The few lines of even the crudest maps convey more than could be expressed by a long verbal description, and convey this more clearly and impressively. It was in furtherance of this idea that the fantastic figures of animals and other characters were added to early maps, and that explanatory notes were frequently introduced. Out of these has grown the elaborate series of conventions which are incorporated in our modern maps. Maps, in the early stage of their construction, were used as guides in exploration and for recording and illustrating State and land boundaries. In later years they were extensively prepared for military purposes. Their value in recording property divisions, and as a basis for land-taxation, led, centuries ago, to the preparation of exact plans or maps known as cadastral maps, which, according to the definition of the term, are maps from which land-areas may be computed and their revenues determined. These were generally without topography at first, but features of relief were added later.

The great importance of topographic maps in military campaigns was perhaps the most powerful among the first causes which prompted their preparation. Once prepared, however, their value for many civil purposes soon became apparent, and this has led to the construction of such maps in almost all civilized countries, on large scales, permitting the introduction of much detail. Nowadays topographic maps are acknowledged as invaluable for the promotion of agriculture, commerce, and mining; for interior improvements, in the construction of railways, roads, canals, and harbors; for irrigation, drainage, and artesian boring; for the management of forests; for determining drainage-areas and reservoir-sites; for delineating the geology and the distribution of mineral products; for illustrating the development of geographic features and for many other educational and scientific purposes; for establishing boundaries and frontiers, and for reference in administration and legislation.

Just how topographic maps are useful in all these connections can perhaps best be imagined by conceiving that a perfect topographic map is like an exact miniature of the surface it represents. It is as if the face of the earth were shrunken to Lilliputian dimensions, and spread out before one on the table for study and guidance. On it are represented a multitude of facts of location, distribution, and altitude, which years of travel and familiarity with the ground would not furnish; and these are presented in such a way that you obtain a comprehensive conception of the relationship of parts which can be acquired in no other way. When to the picture of the relief are added cultural features, such as roads, bridges, and boundaries, or facts of geology, and forestry, or any other occurrences, their locations are so clearly and graphically shown that one can place them on the ground at once.

It is true that for topographic maps to serve all these important ends to full satisfaction they must be of large scale, and constructed in great detail at a corresponding large cost. Probably the smallest scale that will fully admit of all these uses is 1:2500, or about 25 inches to the mile, which is the scale of the "parish plans" of the British Ordnance Survey. In proportion as maps are on a smaller scale than this, or are less carefully constructed, will they fail to meet all the requirements. Still, topographic maps on scales of one or two miles to the inch, constructed with a faithfulness commensurate to the scale, remain valuable for many of the purposes enumerated.

The United States is undoubtedly less satisfactorily mapped, according to modern ideas, than is the territory of any other important and equally civilized nation. Indeed, it is only during the past thirty years that any general topographic mapping of inland areas has been undertaken. A brief reference to these surveys will be in place here.

We are all more or less familiar with the system of public-land surveys which was put in practice towards the end of the last century, and which has continued up to the present date. It has now covered nearly all of the western, and some of the eastern States. By this system the land is divided into townships of six miles square. The maps prepared from these surveys, though serving many useful purposes, lack accuracy in many respects, contain little geographic information, and are entirely destitute of hypsometric data.

The military and other explorations of the western country, conducted during the early part of the present century, though yielding abundant general geographic information, did not produce any maps such as are now classed as topographic.

The ground-work for such cartographic development, therefore, may be considered to have begun, and this in a most admirable manner, with the planning of the United States Coast and Geodetic Survey by Hassler in 1807, though actual work was hardly started before 1832. The work of this survey embraces the accurate delineation of the whole coast-line, including all bays and rivers up to the head of tide-water. Further the work extends inland as far as necessary for coast defense, and out to sea twenty leagues. In addition, triangulation of the highest order and lines of precise levels are extended into the interior, and one chain of triangles will soon be completed across the continent. The charts prepared are of different kinds and scales, ranging from 1:5000 to 1:80,000, with contour intervals of 10 and 20 feet. The majority are about six inches to the mile. On these charts the topography of the land adjacent to the coast is shown with great minuteness, and innumerable facts of value to the navigator are incorporated. Nearly the entire coast-line is now mapped, and in all about 34,000 square miles have been topographically surveyed.

The survey of the great lakes was inaugurated in 1841 and continued forty years. It was conducted under the Engineer corps of the United States army, the work being based upon triangulation of the most accurate character. A narrow strip along the whole shore line of the United States was topographically mapped on scales varying from 1:5000 to 1:600,000. The relief on the older charts was shown by hachures, on the later ones by contours.

Several other surveys by the national government were prosecuted between the years 1867 and 1879. The survey of the Fortieth Parallel was organized for the purpose of exploring a strip of country along the Union Pacific and Central Pacific railways, about 100 miles wide and extending from the western border of Nevada to the eastern base of the Rocky mountains. This was triangulated and mapped topographically with barometric and vertical angle altitude determinations and sketched topography. The field of what is known as the Hayden survey extended into Montana, Idaho, Colorado, Arizona, New Mexico, Utah, and Wyoming, embracing topographic sketch-mapping controlled by triangulation. Under the Powell survey of the Colorado river about 67,000 square miles were mapped in Utah and Arizona ; the work was controlled by triangulation, and the topography was drawn on plane tables. The Wheeler Geographical survey west of the One-hundredth Meridian, begun in 1869 as a topographic reconnaissance, was reorganized in 1872 and continued until 1879 ; about 360,000 miles were surveyed. Under the control of the War Department surveys had been conducted since 1878 in great detail along the Mississippi and Missouri rivers, and a strip of country on each side of those streams has been mapped topographically, work being controlled by triangulation and carefully-checked levels.

The most advanced step towards a general topographic atlas of the country has been made by the existing United States Geological Survey, since its organization in 1879. The work grew out of the necessity for a topographic base in the preparation of a geologic atlas. The maps, though primarily adapted to this end, are, however, calculated to answer many of the other requirements of topographic maps. The work is in great part controlled by triangulation of moderate refinement ; altitudes are determined primarily by vertical angle measurements and secondarily by aneroid barometers. The topography is largely drawn on plane tables by intersections, supplemented by odometer meanders along roads. All reliable results of previous work by other organizations are made use of. The work has now been extended over a large portion of the country both in the west and east, and some few eastern States have been entirely mapped on a plan of coöperation between the national and State governments. Altogether 550,000 square miles have been surveyed.

Besides these surveys of the national government, various States have mapped portions of their territories in greater or less detail, including New Hampshire, New York, Pennsylvania, New Jersey, Kentucky, Wisconsin, Minnesota, Missouri, Arkansas, Texas, and California.

Did space permit, it would be of interest to describe in greater detail the processes and results of all these various home surveys, but we must be content with the following tabular summary of the results to date :

AREAS REPRESENTED ON VARIOUS MOTHER MAPS OF THE UNITED STATES.*

	Square miles.
Scale of 1 mile to the inch, all in contours	100,000
Scale of 2 miles to the inch, all in contours	360,000
Scale of 4 miles to the inch, all but 60,000 in contours	460,000
Scale of 8 miles to the inch, 860,000 in contours ; 160,000 in hachures ; remainder show no relief	1,530,000
Scale of 16 miles to the inch, same as above	350,000
Total	2,800,000

This leaves only about 8 per cent. of our country, exclusive of Alaska, unsurveyed.

Though it would appear that almost the whole of the United States has been mapped, we must not be misled into the idea that this has been done in a final manner. On the contrary, the result so far is only a stage in the development of our cartography. Undoubtedly the great portion of this mapping is inferior to that of European nations, and is not calculated to satisfy the needs of a densely-populated country. But we must remember that the results so far have been attained at a comparatively small cost, to satisfy present needs. As soon as our people become educated to its value to the extent of providing the necessary means, the highly exact cartography will follow.

Money is not the only essential, however, for the production of good topographic maps. Cultivated minds and trained hands must be provided also. It has been no small obstacle to the advancement of such work in this country that competent topographers cannot be obtained in sufficient numbers. We have an abundance of surveyors who can run a level or compass, a transit, or even a plane table, and who have some experience in such topographic work as is generally part of a railway survey. But men who have

*These figures are extracted from a table published by Mr. Henry Gannett, Chief Geographer of the United States Geological Survey, in a paper entitled "The Mother Maps of the United States," in the *National Geographic Magazine*. The reader is referred to this paper for much additional interesting information on the subject.

an eye for topography, in whom what we may call the topographic sense is fully developed, are few and far between. Topographic mapping is far from being a mere mechanical operation. It is a simple problem to determine distances and altitudes and to connect points of equal elevation by contour lines ; but it is an entirely different matter to draw these lines so that they shall faithfully convey the true expression of the topography, without which so much of its meaning must be lost. In this lies the art of topographic mapping, the perfection of which demands an eye for detail.

To effectively practise the art recourse must be had to the science of topography. Topographic forms must be studied, mastered, and classified, and types defined ; their relationships must be understood, and something of their history appreciated. This involves a consideration of the origin and development of the physical features of the earth's surface, and a dip, at least, into the subjects of geological structure and history.

We have a great plenty of text-books and courses of instruction which tell all about the make and use of the many different surveying instruments, which explain the processes of surveying and the preparation of contoured maps as adjuncts to civil engineering ; but of text-books or lectures which attempt to inculcate the principles of the science of topography as here defined, and to train in the art of topographic mapping, there is almost an entire dearth. The most noteworthy move in this direction during recent years has been at Harvard, thanks to the discernment and energy of Professor W. M. Davis, professor of physical geography at that university. The science of geography with especial reference to the origin and growth of topographic features is there taught in a most interesting and attractive manner. We should have more of such teaching, and we *must* have more if cartography in the United States is to reach a high degree of excellence. Skill and training in the mechanical processes must undoubtedly be developed even to the height of an art ; but, over and above this, the higher intelligence must be appealed to if enthusiasm is to be aroused and interest sustained. Only through such intellectual interest in a worthy theme, through such understanding of causes and effects, is the best work done.

RECENT PROGRESS IN SIAM.

By J. B. Breuer, Bangkok.

IT is not so very long since the knowledge of Siam possessed in most western countries related chiefly to the Siamese twins having been born there. Their deformity not only established their own fame around the globe, but made the name of their country known. Some of the better-informed had heard of Siam as the home of the White Elephant, worshipped alike by a diamond-wearing king and a half-barbarian population. But if one had asked the name of the capital of Siam, or to what country Bangkok belonged, correct answers would not, in many cases, have been forthcoming. During the past summer, however, this country has been brought within the focus of general attention and interest in consequence of the diplomatic difficulties with France. The political questions involved have been discussed at great length in the newspapers, but it may be of interest to consider the status of culture and progress in this east Asiatic kingdom, which, as will be shown, fully deserves the sympathy bestowed upon it of late by the civilized world.

Siam seems a small country, as shown on the map of Asia, but its area of 270,000 square miles is greater than that of Germany. The population is scant, however, not exceeding eight millions in all, and rapidly decreasing in density as one travels from the south to the north. The southern part of the country is of alluvial formation, as shown by the discovery at Bangkok of sea-shells twenty feet below the surface. The fertile soil here produces a vegetation of unrivalled luxuriance, from the cocoanut-tree to the most exquisite fruit-bearing species. But the scenery is somewhat dull and monotonous, immense plains alternating with impenetrable, endless jungle. Here is the home of numerous herds of elephants, water-buffalo, wild bullocks, and magnificent stags which are the sportsman's joy. Among the smaller zoological species is a peculiar kind of monkey, with long, grey, silken hair, and a plaintive, human-like voice. Innumerable birds and a large variety of poisonous and harmless snakes are also found. But the level aspect of the country changes toward the north, where a mountainous character prevails. Here is the realm of the tiger,

THE RIVER MEINAM, WITH SIAMESE MEN-OF-WAR.

which, not extirpated systematically as yet, is more frequently seen than in British India. The Malay peninsula, being for the greater part under Siamese rule, and stretching out its long branch down to Singapore, the grand thoroughfare of Eastern trade, is also mostly of a hilly formation.

Two mighty streams flowing from north to south form the chief arteries of travel and commerce in Siam,—the Meinam and Mekong rivers. The delta of the Meinam forms the great natural commercial center of the country. The name of this river indicates the great importance attached to it, being formed from two Siamese words which signify "mother of the water." Indeed, to a certain extent the Meinam plays the same rôle in Siam that the Nile did and does in the land of the Pharaohs. During the rainy season the river, with its affluents, overflows several thousand square miles of country, preparing it for the production of rice, the chief victual for the inhabitants and also the chief article for export.

As in every tropical country, there is a characteristic rainy period in Siam, which lasts from May until the end of October. This period is followed by the cold season, from November until the end of February, and in March the hot season begins, lasting until the middle of May. Of course the term "cold" must be taken in a relative sense, the lowest temperature ever recorded having been 57°. The maximum height of the thermometer is about 98°. Considering such permanently high temperatures, life in this latitude might seem impossible for Americans or Europeans were it not for the two winds called the southwest and northeast monsoon, which yield refreshing breezes at periodical intervals. Still the climate is an extremely relaxing one, and does not fail to exert an enervating influence on the population.

Scarcely half the inhabitants may properly be called Siamese. Two millions are represented by the Laos, a tribe conquered by the Siamese early in this century, clever in industrial arts, and differing from their conquerors little save in dialect. Another million is represented by the smart and warlike Malays, and another million by the Chinese, who, as tradesmen, are penetrating the whole of the far East. Born under an ever-smiling, bright sky, needing little in the way of wearing apparel, contented with rice, a little fruit, and the traditional betel-nut for chewing,—things which the soil offers almost without effort on his part,—the Siamese native knows little of the sorrows of to-morrow. Consequently we find him of a bright, inoffensive, and even careless nature. Like all

VIEW OF THE KLONG (AFFLUENT OF THE MEINAM), BANGKOK.

Orientals he is fond of jewelry, and if he has some money he spends it for purposes of ornamentation for himself, his wife, and his children. Babies overloaded with ornaments of gold and precious stones are a frequent sight in the streets of Bangkok. The Siamese is less active than the Malay and far less busy than the Chinaman. He considers himself a born gentleman, and manifests it by his attire, his walk, and his manners, which are proud, however poor he may be. But he is not unwilling to work, and, although a little slow, is clever in whatever he does. This people is ruled by a king who, surrounded by a court of princes, ministers, and counselors, has made progress the supreme law of his régime. The king of Siam is an ardent protector of strangers, encouraging their commercial or industrial interests in a simply royal way. The great variety of Siamese products suited for export has attracted a large number of foreign settlers, most of whom have met with success. Many European firms, but mostly English and German, flourish on the Meinam, exporting rice, teakwood, cocoa-oil, sugar, sandalwood, skins, and other products. The chief imports are cotton goods, hardware, glassware, petroleum, drugs, and an immense amount of fancy articles. The commodities in which the export trade is conducted on a really grand scale are rice and teakwood. Siamese rice ranks high in the markets, and the teakwood found there closely approaches in value that of Ceylon, which is considered as the very best. Unlike the majority of hard woods, the Siamese teak is easily workable, of very close grain, and, from its oily nature, almost imperishable. Nearly every day steamers start from Bangkok to Singapore and vice versa, making the voyage, according to the monsoon winds, in from four-and-a-half to six days. In Singapore the cargo is transshipped, either on the main line of commerce westward bound for Colombo, Aden, Port Said, and the European ports, or southward for the neighboring Sunda archipelago or for Australia, or eastward for the Philippines.

Transportation between Bangkok and Singapore is maintained chiefly by an English company known locally as the "Blue Funnel line." Though only of medium tonnage,—from about 500 upwards,—they are smart, well-constructed boats, commanded by English officers. The crew are chiefly Malays, these small but vigorous and elastic people making excellent sailors. Another line is owned by a rich Chinese rice company in Bangkok. There is a regular service between Bangkok and Hong Kong, without touching Singa-

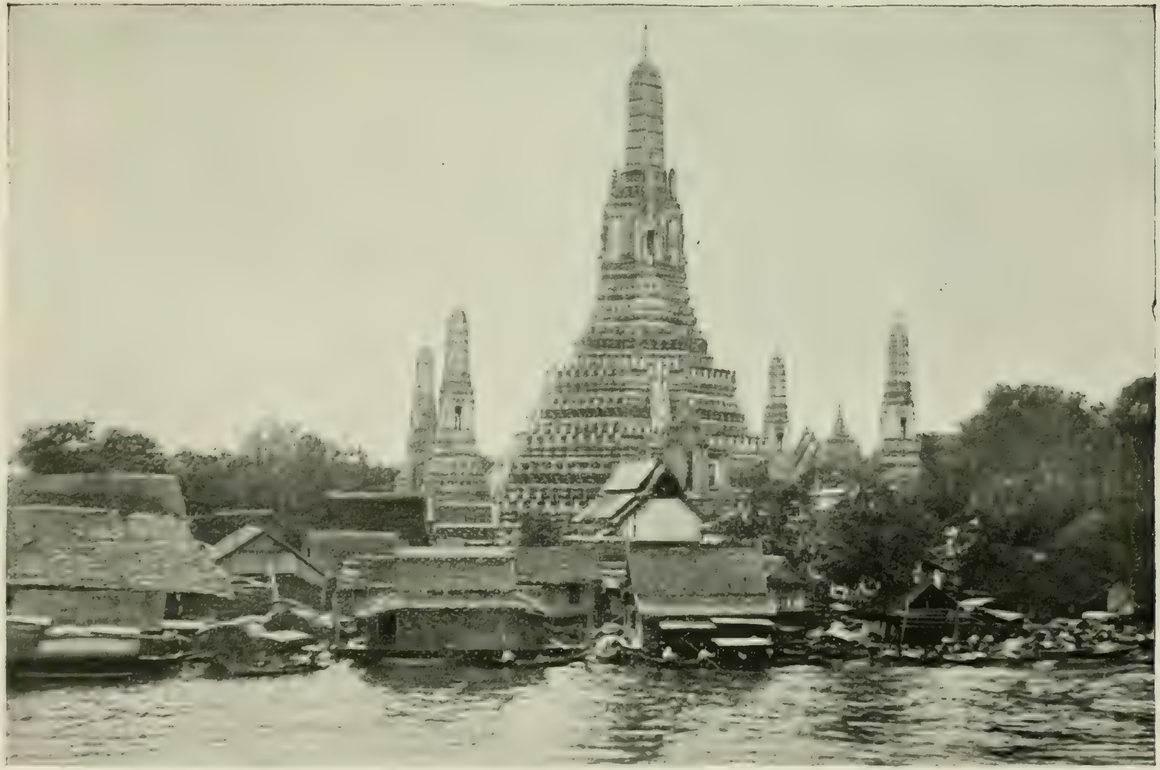
PORT OF KLONG-KHUT-MAI, NEAR BANGKOK.

[Near the starting-point of the Khorat railway, where an imposing terminal building is to be erected.]

pore, by the Scottish Oriental Steamship Company, who have eight first-class steamers, each bearing the name of some monarch or prince illustrious in Siamese history. Bangkok's natural harbor is the river Meinam. Every steamer has to cross the bar at the mouth of the river, thirty miles below the capital. The bar allows large steamers to pass only at high tide, a nuisance of which every ship-captain and every foreign merchant complains. Many times the question has been raised of removing this obstacle by the use of dynamite, but the Siamese government has objected, deeming it wiser to maintain this bar as a natural wall of defense against the big men-of-war in the case of any international difficulties. How slight is its value as a means of defense has been demonstrated lately by the French naval maneuvers, and it doubtless will be only a question of time when the bar will cease to be an obstacle to commerce.

A SIAMESE POSTMAN.

Bangkok, as the capital of the country, is the center of all commercial and industrial movement and interest. The sight of the city from the river, where lie at anchor large and small steamers and sailing vessels, and the primitive Chinese djunks; the tossing and running about of hundreds of load-carrying kulis ; the never-ending humming and singing of rice-mill and saw-mill ; the shrill whistling of boilers and the dull hammering from the docks,—all this leaves

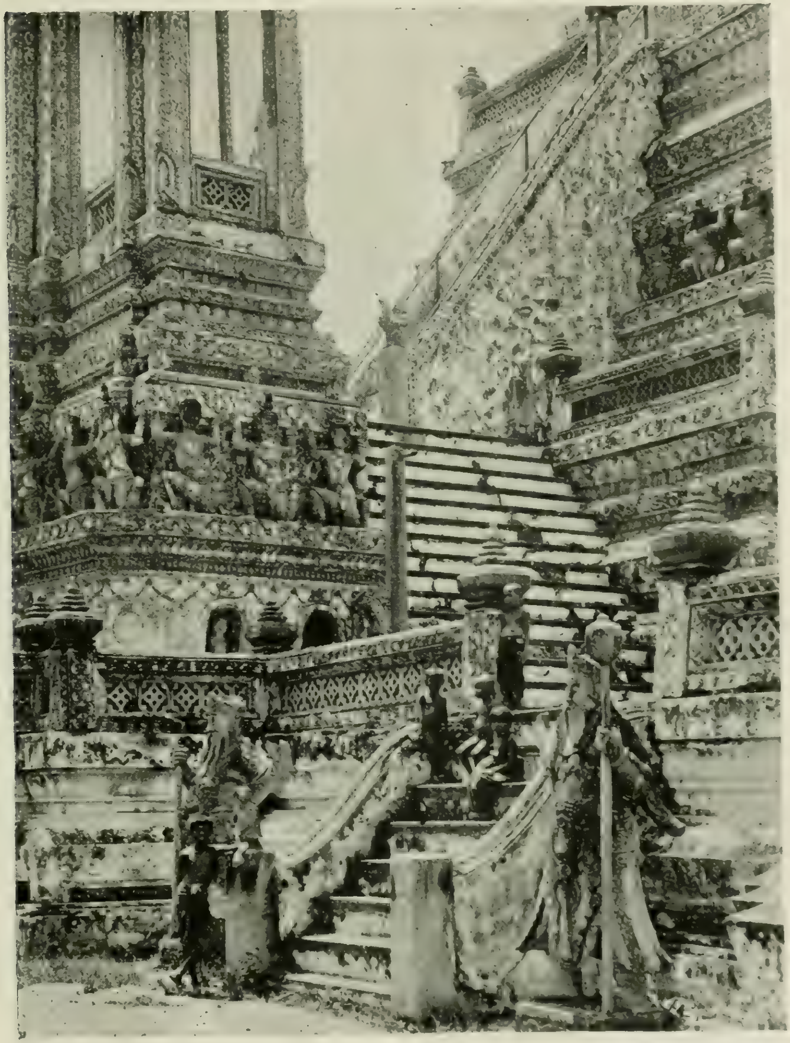


THE WAT CHENG, PRINCIPAL TEMPLE AT BANGKOK.

ARTICLES FOR DINNER SERVICE AMONG WEALTHY SIAMESE.

an indelible impression on a new-comer and makes him feel in the midst of a modern metropolis like Hong Kong, or Shanghai, or Bombay, all three of which are under English rule. But no, we are in the capital of an Asiatic king, though a king whose problem, like that of his father, is to carry forward his subjects in the direction of civilization and progress. Though at the head of a country whose natural products and climate are such as to tempt to inaction, this enlightened monarch and the royal princes in his suite—who have partly got their education in Europe—have made it their constant study to go ahead. They never go backward. It thus happens that there has been brought to the aid of the government a staff embracing many excellent men as advisers in the different branches of administration, which they have arranged on quite modern principles.

Siam has its foreign office, its educational and financial departments, its ministry of public works, and its geological, mining, and agricultural bureaus. Besides, the commercial interest of the country is fostered by a well-managed system of customs,—the merit of which is largely due to Mr. Williams, an Englishman,—and an elaborate postal service, which until lately was under the care of Herr Stratz, assisted by other German postal officers. There is a most



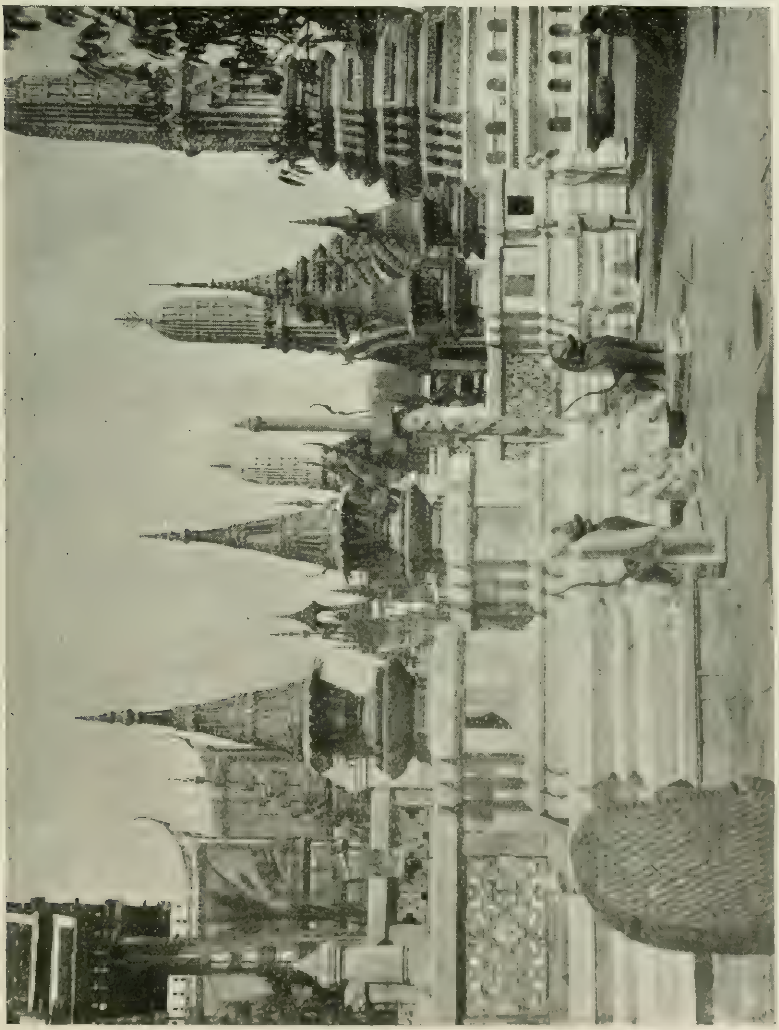
DETAIL OF THE TEMPLE WAT CHENG.

ingenious parcel post and even a money-order system between Siam and the rest of the world. The postal service embraces about forty branch offices in the interior, regular intercourse between which is maintained by steamers, row-boats, elephants, and messengers on foot. Certainly a great deal has been done by the government for the welfare of the country. So far it appears to have been done under an enormous financial sacrifice, but it must be considered that most of the institutions are as yet only in the beginning of their development, time enough for results not having elapsed. Owing to the tropical nature of the country, progress must necessarily be less rapid in Siam than in Japan, but this may be considered rather as a benefit, for the over-hastened development of the Japanese has produced some awkward consequences.

A particularly rich field for agricultural operations is offered in Siam. Immense districts lie inert and uncultivated, partly from the scarcity of population, partly from the want of an adequate irrigation system, and last, but not least, from insufficient means of transportation. Irrigation is partly supplied by the affluents of the Meinam and Mekong rivers, but this water net-work needs to be largely extended, in which direction something has already been done in the cutting of irrigation channels beyond the points reached by the creeks. Roads have been built across the country for connecting the chief provinces and centers of population, but these roads are difficult to maintain. Nothing is more destructive to

A SIAMESE PONY-CART.

roads than a tropical rain lasting for months, and the situation is rendered worse by the incredible energy of vegetation, which entirely closes to-day what the axe cleared away only a few weeks ago. Conveyance on these roads hitherto has been by elephants and bullock-carts, neither of which is rapid or comfortable. Horses do not stand the climate, being subject to many diseases. Ponies are successfully used for dog-carts and other light vehicles, but are not

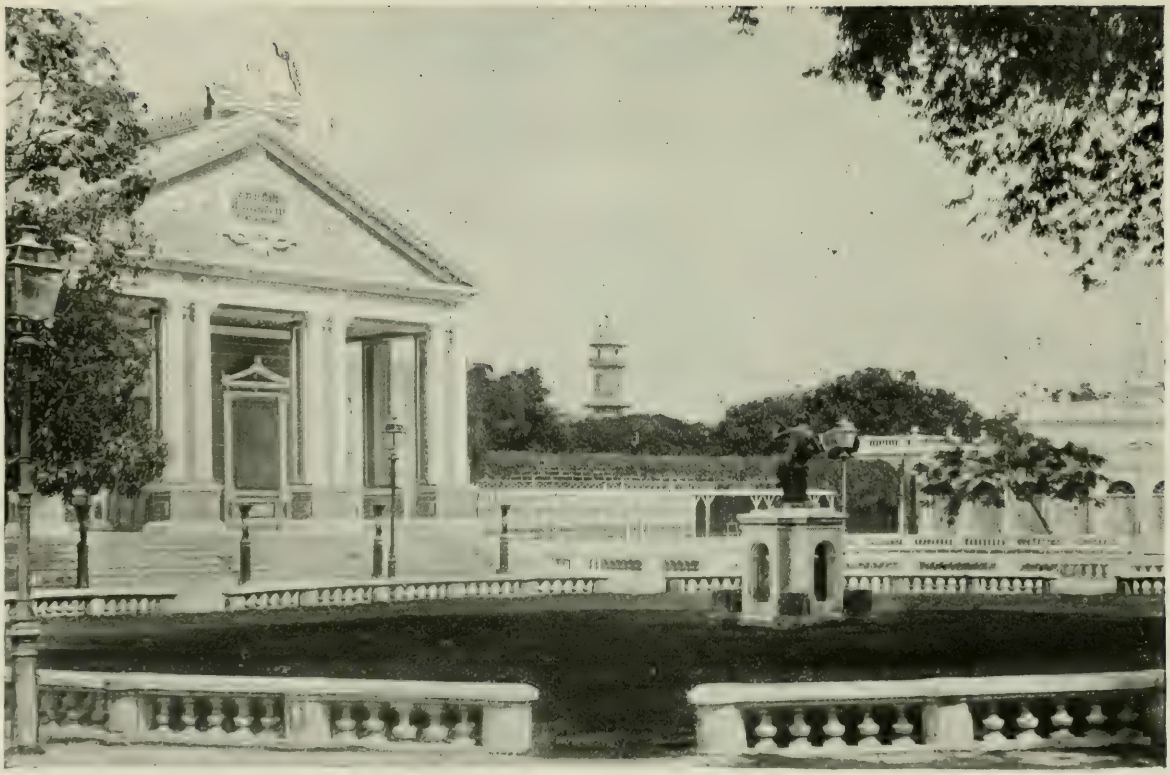


ROYAL TEMPLE COURT, WITHIN ROYAL PALACE GROUNDS, BANGKOK.

BUFFALO-CART AND DRIVER IN SIAM.

available for long distances. It happens, therefore, that the idea of building railways throughout the kingdom has occurred to the government as essential to properly opening the country.

Four years ago some European engineers were called out for the work of inspection. Mr. Bethge, who had been identified with the St. Gotthard (Switzerland) railway, handed to the government a most promising report, and was authorized to push forward a line in a northeasterly direction, connecting the capital with the Khorat mountains, being of about the same length as the shore line leading from New York city to Boston. The lowest tender for the work was that of the English firm of Murray Campbell & Co., to whom the contract was awarded. Both Mr. Bethge, as director general, and Mr. Campbell, as the contractor, have staffs of junior engineers, besides which there is a chief engineer for the government,—a Mr. Rohns, who is of the highest professional standing. It is expected that this line will be completed next year, and, if its operations should prove successful, it will be followed by other similar enterprises, unless the recent Franco-Siamese difficulties should have the



BANG-PAHIN, SUMMER RESIDENCE OF THE KING, NEAR AJUTHIA.

effect for awhile of checking progress. It must be understood that Siam is not fabulously rich, but it has so far avoided public debts. It only remains to see how the country will bear up under the immense contribution forced upon it by the French. Before the Khorat railway was begun there was a short local line already in course of construction between Bangkok and Pak-Nam, at the mouth of the Meinam.

The development of railways is desired not only for extending

THE WAT SAKET, TEMPLE AT BANGKOK.

[Constructed on an artificial hill of brick. Contains a sacred tooth of Buddha, in honor of which there is a yearly procession.]

BULLOCK-CARTS AND GHARRIES (COACHES) IN BANGKOK.

[In the back ground is a Chinese temple.]

A SIAMESE PRINCESS.

agriculture, but also by timber merchants having large interests in teak-wood lying beyond the points reached by river navigation. The export of rice is hampered in many quarters by the low water. The mining industry is also to be considered as promising a further development with the building of railways. Besides the products suitable for export already mentioned are pepper, coffee, gum benjamin, indigo, aloes, cotton, tobacco, and even gutta-percha. Up to date most of these articles have been produced only on a small scale, but the proof is afforded that they exist, and that their production is limited only by the lack of facilities for communication. At least this is an important point of view of the Siamese government. Something may be said in particular about gutta-percha. As is well known, the supply of this important commodity has become a matter of concern on account of the growing scarcity of the trees producing it. While the demand for this substance is annually increasing, and becoming more worldwide, the possibilities of obtaining it are diminishing in consequence of the wholesale destruction of the trees which has long been in progress. In Java it has been almost exterminated, while in Sumatra, Borneo, and the Malay peninsula the stock has been diminished to a ruinous extent. This has induced the formation of a company for the purpose of purchasing and erecting a newly-patented invention by

M. Rigole, of France, for extracting gutta-percha from the leaves and twigs of the *Isonandra dichopsis.* This process will, in the opinion of the inventor, insure a chance of obtaining in a few years an unlimited supply of the very best gutta-percha, the process allowing the tree to be utilized continuously during the whole period of its existence, instead of being cut down and destroyed for a single yield of gutta as is now the rule. An estate has been chosen in the island of Pulo Obin, belonging to the Malay peninsula, near Singapore, for the establishment of a factory and the planting of trees. The government has expressed its willingness to give to the syndicate leases of land, and has also offered to protect M. Rigole's patent within Siamese territory.

A SIAMESE WOMAN.

The government has displayed a liberal generosity in the encouragement of the work in the gold-fields at Bantapan, and also in the sapphire- and ruby-mines. Mr. C. Preston Gibbons left for England a few months ago, taking with him several samples of the ruby-producing strata of various mines of the companies represented by him, for the purpose of putting them through washing-machines and so trying the latter before shipping them to Siam, where they are to supplant Burmese labor. Furthermore, a liberal concession has been given to a leading Bangkok firm for mining coal in the Malay peninsula. But not all concessions given in Siam have yielded great results. Some have proved entire failures, especially through having become the bases of doubtful maneuvers on European exchanges before the first sod had been turned for exploration. Guided by experiences in this line, the government has become more cautious and less prodigal in granting licenses to private companies. There is now a government mining department, at the head of which is Mr. de Muller, an English geologist well known by his work in Australia and South America, and all proposed mining schemes hereafter are to be rigidly examined.

After having been shown what are the prospects for the trader, the planter, and the miner in the interior, the reader is invited to follow us back to the "Residence," which now means Siam even more than Paris means France. One who takes a walk through the city will be surprised at the number of modern royal and other public buildings of tasteful architecture, adapted to the climate by large, overhanging, shady roofs, and ample cool piazzas and verandas. He will see colleges, barracks, administration buildings, a court of justice, jails like those in Colombo or Bombay, children's homes, and a public park where he may be struck by the familiar

FRUIT ON THE TABLE OF A EUROPEAN RESIDENT.

[Including the Duria-fruit, Mango, and Mangustine.]

PALISADES FOR ELEPHANT-HUNTING, ON THE UPPER MEINAM.

sounds of one of Strauss's waltzes or an overture correctly played by military bands. In these colleges boys of the better class learn English and mathematics from European teachers. In the courts of the barracks the infantry, armed with Mannlicher rifles, are drilled to a degree of perfection which would appeal to the interest of a Prussian officer. Then he might pass a ministerial building, for instance, the Foreign office, where messengers are running up and down like bees in a hive, or the wonderful lofty structure of the Hong Kong and Shanghai Banking Corporation, which has its branches in every great commercial center, not excepting Wall street, in New York. There is a huge wooden palace, with the bold inscription "The Siam Electric Light Company," whose managers—it may be said in confidence—made a big failure last year, but who were, by His Majesty's private liberality, most graciously put upon their feet again. There is a regular telegraphic school established in Bangkok, where boys become familiar with Morse's apparatus. Following the main road down-town, an electric tramway equipped by an American company is superseding the horse-cars. At one of the best hotels, or the English or German clubs, one may order a "whisky soda," the great drink of the far East, as temptingly iced as it could be in the best appointed New York club. The ice, a most expensive luxury in this latitude, is provided by the flourishing Ratana ice factory.

After the visitor has seen the country, the people and their manners and customs, and their tendency toward progress, and learned their history and studied their art, he must say that truly the Siamese nation deserves all the attention and sympathy lately bestowed on it by the western world, and that the Siamese have a right to exist as a free and independent people.

While the American or European pioneer need never repent having contributed to the work of civilization in a country so interesting as Siam, there are some serious drawbacks. Siam is not a healthy country, and many a young man full of hopes, and strength, and energy lies buried in the marshy ground of Bangkoks' cemetery, or at some point where he died on his way home when the doctors had sent him off. The water is bad in the city. There are no wells whatever in Bangkok on account of the alluvial formation, and the Meinam water is infected. So the only supply is the rain-water gathered from the roofs in large clay jars or iron tanks. This water is precious, especially during the dry season, and is kept for the use of the cooks. This chief agent in maintaining human life being absent, it is natural that cholera, dysentery, and other diseases should be permanent in Bangkok. But here, too, the government shows a progressive spirit. Engineers have been sent to the Straits settlements, Calcutta, and Bombay to study the best systems for an adequate salubrious water supply for the capital. Systematic filtration of water brought down the river Meinam has been suggested, and also water brought by conduits from the northern mountains. But either system would involve an enormous expense,and the government, not knowing which would really be the better, is still hesitating before making a decision. In addition to the lack of water, the rapid putrefaction of most eatables under the enormous heat must be taken into consideration by every one who thinks of settling in Siam, not to speak of the myriads of ants, mosquitoes, and cockroaches, which are worse plagues than all the tigers and snakes. A few months ago the question was raised of the establishment of a Pasteurian institute. It is earnestly to be hoped that this may be carried out, since few countries have suffered more from outbreaks of cholera and small-pox in proportion to their population. Before Mr. Haffkins or any other Pasteurian disciple visits Bangkok for any such purpose, however, the government will do well, by taking a decisive step on the water question, to strike the evil at the root. But as frequently happens in Oriental matters, though good will and the best intentions may exist, things are often taken by the wrong end.

EFFECTS OF BRITISH SHIP SUBSIDIES.

By Thomas Rhodes.

IT is impossible to say definitely what amount of aid the British government has afforded to national shipping interests. But if the amount was known it would be equally impossible to estimate the effect of such aid with sufficient exactness for the result to be worth serious consideration. The so-called subsidies granted are on record, and so are the successes and failures which attended the undertakings associated with them. All this, however, amounts to nothing. Had the pecuniary support to the steamship companies been given in stricter accordance with the term employed, as the system is at present ; had payment for service rendered not been blended and confounded with payment for the supposed or real forwarding of imperial interests,—there would have been data for theorists to conjure with. As it is, the figures would form a very unsatisfactory base to build even a theory upon. It is the old tale of well nigh every inquiry connected with political economy : the circle is "vicious," and arguments *pro* and *con* might be sustained forever. Nothing remains, therefore, but to treat the subject "historically."

It is generally supposed that British shipping interests have received from time to time very substantial government support, and there is no doubt that, on certain occasions, the government has had this end in view when entering into arrangements with ship-owners. But care must be taken to distinguish between individual and general interests. It is possible for the government to help one or more individual ship-owners to fortune by means of subsidies and, by so doing, to stifle all other efforts which, if given a fair field, and not overmatched by the government grant, would establish a business founded on sound, independent initiative and energy. A policy of this kind is—to deal with single factors—equivalent to bolstering up one individual in order to down competition at home and provoke it from abroad. For example, A, B, C, and D are ship-owners, A and B of one nationality, C and D of another. A obtains a subsidy from his government. It necessarily follows that, with this circumstance to back up their application, either C or D is sure to obtain similar aid from their government. The result is that internationally the two efforts are nugatory, while at home each government lends itself to crushing one of its own subjects in order to enrich another and render him less alert in his business, and to hold back the development which competition engenders.

On this account I hold that the British government has afforded no real aid to the shipping interests of the country until quite recently, and to a very slight extent. For the purpose of a cursory examination of the question we need go back no further than the inauguration of the transatlantic steam mail-service in 1840. And as that service forms as good an exemplar as any, we may, without great loss, restrict ourselves to it.

In 1838 the possibility of crossing the north Atlantic under steam alone had been satisfactorily demonstrated. In the year following, Mr. (afterwards Sir Samuel) Cunard, a Canadian of the Napoleonic type,—of which, by the way, there are still some good specimens,—came to England and induced two of the leading steamship-owners of the day to join him in an offer to the British Admiralty to undertake a regular steam mail-service between England and North America. Of the progress of Mr. Cunard's negotiations there is, I believe, no record. The outcome was a contract signed July 4, 1839, for a fortnightly service between Liverpool and Halifax "by means of a sufficient number of good, substantial, and efficient steam-vessels—furnished with engines of not less than 300 horses power," with branch connecting services between Pictou and Quebec and Halifax and Boston. The contract was for a period of seven years, and the subsidy £60,000 per annum. It must be borne in mind that in those days mail contracts were matters controlled by the Admiralty and not the Post-office. According to O'Connell's well-known saying, "a fine speech is a very good thing, but the verdict is *the* thing." Mr. Cunard was a consummate negotiator. His correspondence with the various government departments is generally inconsequent and entirely innocent of logic, but he invariably carried his point. One sees the same phenomenon in law courts. To the amazement of his client counsel will throw overboard the carefully rivetted evidence in his brief and set out upon a sentimental speech utterly devoid of argument—and win his case. He knows his men. Accordingly we find Mr. Cunard sailing pleasantly along to the year 1868, the subsidy being increased to £80,000 in 1841, and to £145,000 in 1848, in return for an increase in the horse-power to 400 and a service to New York, making forty-four transatlantic voyages in all per annum ; and subsequently declining again to £80,000.

Now, while approving the course adopted by Mr. Cunard and admiring his success in it, I nevertheless maintain his State-created ascendency to have been distinctly prejudicial to the natural development of British shipping within the sphere of his activity. I go further and assert that the Cunard line has had since to pay for the unsound traditions it inherited from this era of unnatural, and therefore unsound, development. Lest it should be thought there is something inconsistent in approving a course and at the same time accounting it prejudicial, I will explain how the two might be reconciled. Let a ship-owner get all he can, but, if he wishes his line to live and prosper, let him distinguish between undeniable trade earnings and the proceeds of "diplomacy."

Various attempts were made to fight through this monopoly, but without success until Mr. Inman became formidable enough to compel the Cunard company to admit him to share in it, in 1869. Among the petitions presented to Parliament in this connection were two in 1846 from the directors of the Great Western Steamship Company, in which, after praying they might be allowed to tender for any new business, they call attention to the fact that, though they were the first to build and send to sea a steamship for the purpose of solving the disputed problem of transatlantic steam navigation, and that the establishment of transatlantic steam service was due to their enterprise,—notwithstanding these important circumstances, which ought in their opinion to have secured favorable consideration for their line, the government "was seemingly in league with their competitors to crush them." More instructive still is a somewhat voluminous parliamentary return, in 1853, containing copies of the correspondence relating to an application on behalf of the promoters of the London, Liverpool, and New York North American Screw Steamship Company for the grant of a royal charter of incorporation,—*i. e.*, for permission to form a company with limited liability. The attempt was held up as an iniquity. Mr. Cunard declared it would be an injustice to set up a company possessing the advantage of limited liability to compete with those who had embarked their own capital in the trade, adding, with his naïve contempt of logic and ingenuous appraisement of official intelligence, "because these companies are frequently got up by persons who know nothing of the business—and who will be aware that individuals cannot stand out against them with their limited liability." Mr. Cunard was, however, on this occasion, either not alone in his opinion or without influence, for, incredible as it may appear to-day, petitions poured in upon the government from many of the chief commercial centers against the gross injustice of the contemplated charter.

This particular case is so characteristic as to be worth a little special attention. The promoters of the proposed company asked for nothing but permission to come into existence. They backed up their request by pointing out that in April, 1851, Mr. Cunard had stated that the property belonging to himself and partners represented an accumulation of undivided profits amounting to a million sterling, that at the time (in 1852) the Cunard line was receiving no less than £186,000 per annum, and consequently "it may be easily conceived how much more rapidly their accumulation of profit must be going on and their power of crushing opposition be increased." The Board of Trade refused to grant the charter on the ground that, "looking to the amount of private enterprise already engaged in the carrying trade by means of screw steamships between this country and the United States of North America, their Lordships are unable," etc. And their Lordships had the subjoined figures when they came to this decision:

SHIPS CLEARED FOR NEW YORK.

At London:	United States sailing ships...........	68,074 tons
	British sailing ships..................	931 tons.
	[No steamer of either country.]	
At Liverpool:	United States sailing ships..........	312,798 tons.
	British sailing ships..................	37,074 tons.
	United States steam ships	37,560 tons.
	British steam ships..................	32,170 tons.

In 1853 the governor of Canada wrote to the home government protesting that Canada had to pay a large subsidy for a line of steamers running into the St. Lawrence simply because Her Majesty's government gave a large bounty (?) to a line running to foreign ports. Again, in 1859, in a memorial from the Legislative Council and Commons of Canada occurs the following: "We learn with regret that it has pleased your Majesty's government to renew the contract with the Cunard company without an opportunity having been afforded to the government of Canada to urge such arrangements as would have been conducive to the prosperity of the colony." In 1857, long before the expiration of his existing contract, Mr. Cunard applied for an extension on the plea that the Americans were about to build much bigger and more powerful steamers, and he must do likewise or submit to being extinguished by them. He could not, however, he said, afford to build the class of vessel required to meet the threatened competition unless his subsidy was guaranteed to him for a term of five years beyond his existing contract. " Such powerful and expensive ships," he added, " as are required for this service are totally valueless at the termination of the contract—the *Persia* consumes upwards of 160 tons of coal a day—the wear and tear and other things are expensive in like proportion. No other employment would support such frightful expenditure." The Lords of the Admiralty recommended the Treasury to accept the proposition, but the Postmaster General, the Duke of Argyll, thought otherwise, and his letter to the Treasury might have been written to-day, so sound and in a sense prophetic are the principles he lays down. His objections were, in fact, unanswerable. The Admiralty replied by declaring it to be the Postmaster General's business to see to the conveyance of the mails, theirs to decide the class of steamers needed. The Treasury declined, however, to accede to Mr. Cunard's request. But he knew his men, persevered, and within eighteen months got what he wanted. " The Americans," he wrote, " are extending their mail-service over almost every navigable part of the world and will, in many places, have the entire monopoly. They would have had it on the Atlantic long since, if I had not, at great risk and danger, taken up the decided position I did." And so the Treasury, with the unanswerable logic of the Duke of Argyll's letter before them, and in direct opposition to the report of a committee of the House of Commons, in their own words " arrived at the opinion that an extension of this contract may without further delay be conceded as a matter of great public importance."

I am unfortunately unable to track closely the progress of American steam shipping. For the years previous to 1860 no figures are available, and, more regrettable still, none are given for the years between 1860 and 1870, except under the head of tonnage sold to foreigners. Thus what would have been, had not the civil war occurred, can only be surmised. For my own part I believe the question of competition for the United States was already settled for many years to come, and that the war merely hastened and emphasized the inevitable. The substitution of iron for wood in construction and the splendid opportunities offered to capital by domestic undertakings in the States after the war were preponderating influences in favor of British shipping interests.

TONNAGE OF STEAM VESSELS BELONGING TO—

	United Kingdom.	United States, Registered for over sea.
In 1840	87,539	4,155
In 1850	167,698	44,942
In 1860	452,352	97,296
In 1870	1,111,375	192,544
In 1875	1,943,197	191,689
In 1890	5,037,666	197,630

If we regard iron as introduced in 1850 (Inman liner *City of Glasgow*), it will be seen that the rate of progression was virtually the same from that year before and during the war, and that it has practically stood still ever since.

The figures of the tonnage sold to foreigners by the United States shipbuilders are even more striking,* viz.:

In 1850	13,468	In 1865	133,832
In 1860	17,418	In 1866	22,117
In 1861	26,649	In 1867	9,088
In 1862	117,756	In 1868	13,757
In 1863	222,199	In 1890	13,322
In 1864	300,865		

In maintaining the civil war to have been a minor cause I am aware I am at variance with high authorities. The *Times*, for instance, on the occasion of the transfer of the *City of Paris* and the *City of New York* to the American flag, observed: "There was a time when the shipping industry was one of the most flourishing in America, and when vessels built and owned in that country played a prominent part in the carrying trade of the globe. The fabric of prosperity built upon this basis, however, fell down like a house of cards when struck by the shattering blow of the civil war." Yet I venture to believe that the true causes were those I have mentioned.

In 1860 an act of Parliament transferred to the Postmaster General the powers up to that date exercised by the Admiralty as regards the conveyance of mails by sea, and thenceforth an entire absence of sentiment is noticeable in official dealing with ship-owners. Meanwhile the commercial community was hastening the downfall of the fixed subsidy by making its voice heard in favor of sending a mail by the German steamers calling at Southampton, and for

*The years for which the larger figures appear in the table comprise the period of the civil war.

the last year of the Cunard monopoly the amounts paid were: Cunard, £80,000 by fixed subsidy; Inman, £22,161; North German Lloyd, £9504: Hamburg-American, £3343 by weight of mails carried. By the next year Mr. Inman had asserted his claim to participate in the subsidy, which accordingly stood: Cunard, £70,000 for a service twice a week; Inman, £35,000 for a service once a week, the contracts being for seven years,—namely, until 1876. The Hamburg-American dropped out of the arrangement, but the North German Lloyd continued to carry a mail which was paid for by weight throughout, except for one brief period. But though the system of subsidies was continued it was by now universally condemned. Hardly were the last contracts signed when a select committee was appointed to go thoroughly into the question, and its report, issued in 1869, recommended that the contracts entered into with the Cunard and Inman companies should be disapproved, compensation being made if necessary, there being no longer any sufficient reason for fixed subsidies for a term of years. Bnt the government did not feel competent to cope with the situation the adoption of this recommendation would have brought about, and it was not acted upon.

In 1870 the White Star line appeared upon the scene, and by 1874 the *Britannic* and *Germanic* were making a reputation for fast passages. With another string to his bow the Postmaster General was enabled in 1877 to apply the principle of payment by weight of mail matter carried universally, the great English companies receiving 4*s* per pound for letters and 4*d* for printed matter, and the North German Lloyd 2*s* 4*d* and 2*s* respectively. About ten years later the then Postmaster General, the late Mr. Fawcett, made a serious effort to reduce the rate of payment to the minimum fixed at the Berne Convention, and for a short time the great English companies carried no outward mails, and lawsuits were in the air. Eventually an arrangement was come to in 1887, which is still subsisting, and by which the Cunard and White Star companies carry all mails except specially-addressed letters, and receive payment at the rate of 3*s* per pound for letters and 3*d* for printed matter, closed and transit mails being paid at special low rates. These contracts are terminable by twelve months' notice on either side.

Thus to-day there is as near an approach to free trade in the carriage of the British mails to the United States as can reasonably be expected, considering "the nature of man and condition of things." The men at the head of the great transatlantic lines would be more than human, and unquestionably remiss in their duty to their shareholders, were they to accept a penny less than their position enables them to demand. They receive nearly double the Convention rate of 1*s* 9½*d*, because they are strong enough to say "that is our price." It is true every one is now at liberty to send his correspondence by whatever steamer he prefers. But the correspondence of the merchants, who make all the ado in these affairs, forms an insignificant percentage of the whole. The bulk of all mails is contributed by people who would never dream of troubling as to how a letter is to reach its destination.

A splendid testimony to unaided effort exists in the White Star Company and also in the North German Lloyd, neither of whom has received a penny of subsidy; but any instructive financial comparison between them and the older line is out of the question, owing to the break in the constitution of the last when it was formed into a joint stock company. I should say too that the free trader would find a strong argument in his favor in the position of the French on the north Atlantic. With a bounty on construction amounting to about £25,000 on a vessel like the *Bretagne* and substantial navigation bounties (on a complicated scale ranging from 1*fr* 50*c* per ton per 1000 miles to French-built ships in the first year, 1*fr* 45*c* in the second, and so on for thirty years, and half if foreign-built)—with every American, so to speak, making for Paris,—they have but a single great line, running one steamer a week.

At the outset I remarked that the British government has afforded no real aid to the shipping interests of the country—until quite recently and to a very slight extent. In 1885 there was a war "scare," and some £600,000 was expended in retaining the services of several fast merchant steamers. Experts declared these to be of very doubtful utility, owing to the exposed position of their machinery and general unsuitableness of their internal disposition. Two years later, when negotiating the mail contract, Mr. Ismay pointed out to the government how the objection of the experts could be met and a supply of mercantile cruisers, suitable in point of speed and construction to be included in the reserve fleet of the navy, made always available. The suggestion was put into definite form by an offer on the part of the White Star line to build two vessels under Admiralty supervision which should be at the disposal of the government at any time either for purchase or charter at fixed prices and rates, the Admiralty to pay in return an annual retaining fee of 15*s* per ton for at least five years, to be advanced to 20*s* for any part of that period during which the company should not hold the contract for the American mail. Mr. Ismay's suggestion was accepted as sound and reasonable, the *Teutonic* and the *Majestic* were laid down, and the Admiralty announced their readiness to grant the same subvention to any British steamship company under corresponding conditions. Not only was it paid to the Cunard company on account of the *Umbria* and *Etruria*, but also to the Inman and International company on behalf of the *City of Paris* and *City of New York* so long as they continued under the British flag, although they were not built in accordance with the conditions implied in the letter on the subject from the Admiralty to the Treasury.

Given equality in other respects, government aid must of course turn the scale. A much larger sum, however, than any government would be likely to give would be needed to place an incompetently managed association on a level with those famous lines whose house-flags are the pride of their country. The talents required for the successful direction of a great mail-line are not unlike those which go to make a successful commander in the field; grasp of detail, confidence in the settled "plan of campaign" in the face of untoward events, reliance in the estimate formed of the capacity of subordinates and courage to give them a corresponding freedom of action in their departments, and so on. If it is permissible, without offending by a seeming impertinence, I would parody the Duke of Wellington's reply to one who remarked that when in India the Duke's chief occupation appeared to be procuring bullocks and rice. The Duke replied it was so, because if he had the wherewith to feed them he could get soldiers, and with soldiers he could secure victory. I would say, see to your beef and coffee, see they are good, not merely when they go on board, but when passengers take them, and you will have passengers, and with passengers dividends. In years past it was safety before all things; safety we have; the demand to-day is for comfort.

SCIENCE AND SPORT IN MODEL YACHTING.

By Frederick R. Burton.

NO European traveler who spends any time in Kensington can fail to be struck with the number of elaborate toy sail boats that are carried along the streets by men. Few of these boats are less than three feet in length, and they are always completely rigged, beautifully painted, and finished in every detail. Jumping at conclusions, one imagines a small army of boys made happy by indulgent fathers who have given them unusually attractive and expensive playthings; but though many a small boy launches his ship on the ponds in London's parks, these boats, carried as gingerly as if they were made of glass, are not for the amusement of children; they are for the recreation and entertainment of elder people, furnishing the means to a sport unknown in America, and an incentive to study in construction and navigation that stands quite apart from other problems that interest the marine world.

At first blush it seems ludicrous that grown men should spend time and money in sailing miniature yachts upon a sheet of water but a few acres in extent; extraordinary that, instead of playing with their toys on some remote, sequestered pond where none but birds and cattle could see, they choose the most public spot available in London, and there disport themselves with all the eagerness of children, with more than the devotion of boys to their game, with all the intelligence and keenness of observation that characterize the sailing of forty-footers in great regattas. But there they are, strange as it seems to the unfamiliar spectator, carefully setting the sails of their tiny craft, pushing them out upon the water, running along the bank with sticks ready to poke the boats away should the wind drive them to the shore, excited and anxious concerning the speed and behavior of the little vessels, unmindful of the watching crowds save as a victorious skipper may feel a glow at his heart when hand-clapping and cheers proclaim the esteem in which crowds always hold the winner. Such a scene may be witnessed at the Round Pond, Kensington Gardens, every pleasant secular day from April 1 to November 1, and on every Thursday there is a formal regatta for prizes. On other days scratch races are sailed, or owners experiment with their boats, trying the effect of changes in rigging, different sizes of sails, testing the capacity to beat to windward, and so on. Now and again among these ancient playfellows there may be seen an inventor, or manufacturer of marine toys, making experiments with his new creations, but most of the navigators are men whose fortunes remove them far from the currents of commerce.

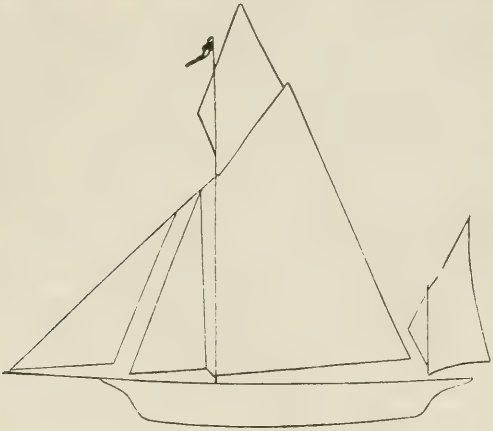


FIG. 1.
Model Yacht, old style.

Old men—that is, men whose childhood is in the hazy past—play at sailing toy boats? Bless the stars! yes; and more than that, they form clubs for the purpose, as the charter of one club has it, of "the improvement of model yacht building, and the encouragement of model yacht sailing." There are nearly a hundred such clubs in England, some with entire buildings devoted to their use, others occupying suites of rooms; there is even a little periodical published in the interests of model yachting, in which may be found the records of races, news concerning the latest boats, novel ideas for construction, technical discussions as to sail measurements, depth of keel, shape of hull, etc.

The Round Pond, or Basin, in Kensington Gardens, is the principal place in Great Britain for model yacht sailing. Three organizations have their headquarters in club houses near by, the most important of which is the "London Model Yacht Club." See with what impressiveness and dignity this apparently childish sport is conducted; the following list of officers is copied from a little book containing the constitution, sailing rules, etc., of the London club:

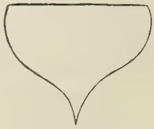


FIG. 2.
Section of hull amid ships, old style.

President, Prince Batthyany-Strattman; Vice-President, Sir Algernon Borthwick, Bart., M. P.; Commodore, T. F. Drinan, Esq.; Vice-Commodore, Capt. R. Methven; Captain, S. E. Johnson, Esq.; Hon. Secretary, Walter Greenhill, Esq.

The entrance fee to this club is ten shillings, and the annual dues a sovereign. The constitution is much like that of other clubs devoted to special objects, but to provide against discord discussion of religious or political topics is expressly forbidden. Another clause introduces an odd bit of parliamentary procedure, and reminds one of the international supreme court recently suggested by Mr. Labouchere ; in case of a tie, the chairman has a casting vote in addition to his own. The walls of the club house are covered with pictures of model yachts of various designs, and with drawings and plans. The diagrams that accompany this article were made from complete yachts set up in cabinets and on tables in the club rooms.

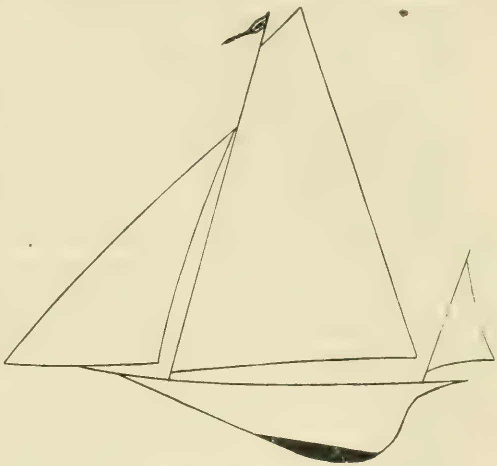


FIG. 3.
Model Yacht, present shape.

It need not be said that the conditions that confront the builder of model yachts differ considerably from those with which Mr. Beaver Webb or the late Mr. Burgess had to deal. In the case of the miniature craft the conditions may differ so materially in different localities that a model eminently serviceable for the Round Pond might be second rate at Victoria Park or at a pond in Liverpool. In general, however, the Bermuda yawl, as shown in Figure 3 (section of hull, Figure 4) is the design now in vogue in Great Britain. Slight variations appear according to local conditions, but the variations figure more in the ballasting and in devices for steering than in the "lines." Some of the yachts in the London Club fleet have ingenious rudders adjusted with movable weights so as to work automatically. These devices are the inventions of members, and it should be said that many of the members make their own yachts from keel to pennant, including even the nickel or silver plating of the metal fittings.

FIG. 4.
Section of hull amidships, present style.

The Round Pond is an artificial basin of water 250 yards in diameter. It was constructed as an ornamental feature of the park surrounding Kensington palace, once a favorite residence of royalty. Queen Victoria was born there. The palace, partially concealed by trees and shrubbery, stands a short distance to the west of the pond. Model yachtsmen have to contend against two peculiarities in sailing their boats there. One is the variableness of the wind due to the several avenues lined by great trees that lie near the borders of the pond. Another is the presence of weeds in the water. The bottom of the pond, five feet below the surface at the greatest depth, is not concreted, and, though the water was drawn off and the basin thoroughly cleaned seven years ago, the weeds have since appeared in as great profusion as ever. Under the circumstances, therefore, it requires no little skill to set the sails of a model yacht so that the craft may avoid obstructions and not be unduly influenced by erratic whiffs of air. Under proper conditions the boats will jibe naturally, and one of the objects of the navigator is to start his yacht upon such a course that she will jibe at the right time. It is quite the regular thing, however, when not sailing directly before the wind, to set the course for a point on shore part way between the start and finish stations. The boat once started, the navigator runs along the shore to the point indicated and waits, stick in hand, for the craft to arrive. This stick must not be longer than four feet, and in using it the navigator must not step into the water. Moreover, when he turns his boat, he must not walk in the same direction in which the boat is sailing. This is to prevent giving the boat a push, the only push allowed being one by hand at the starting station.

The following extract from one of the sailing rules gives a clearer idea of the way model yachts are raced than a column of description :

" * * * If in running a boat comes to the shore, she may be turned off with the stick placed against the bowsprit, or forward gear outboard. When in beating a model comes to the shore, she shall be put fairly about by turning her head off with a stick placed on that side *only* of the bowsprit or gear outboard forward which is to leeward as she comes in, steadying her round by placing the stick against that side *only* of the boom or gear outward aft which is to leeward as she goes out till her sails are full."

And when the boat is well about and speeding on the new tack, away scampers the ancient navigator to the other side of the pond to repeat the operation with his stick, all anxiety to get his boat across the finish line ahead of her rivals.

Races are sailed on the tournament system with a somewhat complicated method of counting. For instance, the boat arriving first within the winning boundaries after a beat to windward counts three to her score. The boat first in in a run (or reach) counts two. Then there are handicap penalties in the various classes, for the boats are classified according to measurements as strictly as are those that carry their skippers on board ; and this recalls another pleasing feature of this gentle sport—classification is fixed in tons ! Thus, there are 10-ton boats, 15-ton, and so on. Handicapping is effected by scoring points against winners of first prizes, three points "off" in subsequent races for the first prize, two more for the second, and one point additional for each succeeding first prize. These and similar other penalties stand only throughout a single season. With the beginning of a new yachting year, the boats start unencumbered by handicaps.

Round Pond became the leading water for model yachting in 1884, when the London club was organized. At that time the boats were of the pattern shown in Figure 1, section of hull, Figure 2. The evolution to the present style, Figures 3 and 4, has been gradual, every year bringing forward several experimental changes, some of which were adopted. It will be observed that the number and shape of the sails has been reduced, the mast set much further forward, the proportions and shape of the hull radically modified. Enthusiasts with ideas of their own frequently bring new models to Kensington to sail against the crack flyers of the London club. Not long ago an Australian appeared with his challenge and a model of unusual build. His name was Stubbing, and he came from Moor Park, Sydney. One feature of his craft was a fin running fore and aft, sunk in a groove in the keel. He failed to win a race on the Round Pond, but he was victorious over all the clubs against which he sailed in the northern counties of the kingdom.

Inasmuch as this quaint sport requires skill and no small degree of scientific study, though applied to small things, there seems to be no good reason why it should not be adopted in America. It supplies a picturesque element to public parks, and is fascinating to spectators and navigators alike. Here are some figures that will be intelligible to yachtsmen and interesting to any who may like to try their hands at building model yachts. According to the London club measurements, a boat 36 inches in length on the load water line should have a sail area of 2500 square inches to make its rating 15 tons. The sail area decreases gradually with the length on the load water line until it becomes 2000 for a craft of 45 inches. This is the rule for determining whether a boat shall be rated as 15-ton or first class : multiply the length on load water line by the sail area and divide by 6000. Thus—l. w. l. 45 × S. A. 2000 = 90,000 ; divided by 6000 = 15. Rule for second class, or ten-ton : length on load water line added to beam, squared, multiplied by beam, and divided by 1730, or, expressed by formula,

$$\frac{(\text{l. w. l.} + \text{B})^2 \times \text{B}}{1730} = \text{tonnage.}$$

The beam of a 10-ton boat, l. w. l. 36, should be $8\frac{5}{8}$ inches, the beam in this class gradually decreasing with the increase of length until it becomes l. w. l. $42\frac{1}{2}$, beam, 7 inches.

There have been many differences of opinion between British and American yachtsmen on the subject of measurements and classifications, and unbounded argument relative to the merits of various designs for racing craft. It is just possible that there may be valuable suggestions in the ideas practically applied by the English gentlemen in the construction and sailing of their miniature yachts. Three striking characteristics of model yachts are shown in Figure 3 : great draught ; large sail area ; and the extreme forward position of the mast. The first and third of these features make the second possible. In ocean yachts large sail area is a desideratum to be obtained with as little displacement as possible, due attention being paid, of course, to stability and facility in handling the boat. Without regard to how this is obtained in the great yachts it will be observed that in the London model the hull slants slowly upward from the extreme depth aft until it meets the deck line in an acute angle forward. Boatbuilders will see that this device keeps the center of gravity and the center of buoyancy in relatively correct positions, while displacement is not increased by increased draught. It must be left to designers to decide whether such lines as are indicated in Figure 3 would be practicable for a deep-water racer, but here is a striking and suggestive comparison : the famous *Puritan*, conqueror of the *Genesta* in 1884 in the race for the America cup, carried sails of 8000 square feet (approximate) area. Her style of rigging was very different and more elaborate than that applied to models, but, if the *Puritan* had used the rig indicated, she could not have carried nearly so much sail. This may be shown by a simple proportion. Take a 40-inch model with a sail area of 2250; for the purposes of comparison it will not be necessary to reduce the *Puritan's* sail area to inches; the proportion would, therefore, be expressed in terms of length to sail area thus:

$$40 : 2250 :: x : 8000.$$

This reduced shows that a boat yawl-rigged to carry 8000 square feet of sail would have to be more than 142 feet long on the load water line.

The question of the relative efficacy of rigs, etc., becomes very complicated. The *Puritan* with its sloop rig was less than 90 feet on the load water line, but there is certainly something worth studying in the effectiveness and simplicity of the yawl as shown in the model. Moreover, American ingenuity might readily discover a design for model yachts founded on our accepted lines that would outsail the most be-medaled craft that ever cut across the Round Pond. The establishment of such a sport as has been described could not but be valuable in an educational way, for it would furnish an incentive to the study of boatbuilding to those who are prevented by circumstances from observing the operations in the great shipyards and the studios of eminent designers. It costs much to test a theory with an ocean yacht; and for this reason, probably, boat building has always made progress more by observation after construction than by scientific research in advance. Model yachts are expensive as playthings, but as models for the study of larger craft they would put the study of construction within the reach of many bright minds whose possible inventions and discoveries are now unthought of and impossible. And as to the sport I cannot see that there is anything more undignified in racing toy boats across a pond than in knocking small balls about on a green table.

THE CAMEL AS A FREIGHT-CARRIER IN AUSTRALIA.

By Edmund Mitchell, A. M.

IN the engineering profession transportation is a factor only inferior in importance to invention and construction. The most perfect mining plant, for example, is useless unless the machinery can be carried to the field of operations and the products resulting from its employment brought back to the markets of the world. To-day the railroad holds undisputed empire on land among transporting agencies. In America it has driven the bullock-teams from the plains of Utah and, in large part, the steamboats from the broad waters of the Mississippi. But there are still territories in which the old methods of transport have not lost their usefulness. In this paper I propose to show how the most ancient form of land transportation is being profitably employed in the most recently settled country in the world. I refer to the camel caravan and to Australia. The work that the camels are doing in the Australian colonies, in connection with exploratory and survey expeditions, in opening up new pastoral country, and in facilitating mining operations in arid regions, is simply invaluable.

It happens that so late as December last I was detailed to make a special investigation into the camel question in Australia. In the course of my inquiries I traveled nearly 2000 miles; visited the quarantine station at Port Augusta, in the colony of South Australia, where the recently-imported animals were graduating for a clean bill of health prior to being distributed over the interior; interviewed the leading Asiatics engaged in the import enterprise; conversed with Sir Thomas Elder and Mr. Phillipson, the manager of Beltana sheep-station,—the pioneer Englishmen in opening up the new industry; secured from Mr. David Lindsay, leader of the recent Elder exploration expedition, autograph excerpts from his diary bearing upon endurance shown by camels traversing the great Australian desert; saw the loading and starting of caravans for the far back blocks; and mingled freely with the swarthy Pathan drivers who have been imported with the animals and are adepts at their management.

CAMELS TRAVELING OVERLAND IN AUSTRALIA, WITH SUPPLIES.

The facts I have to state will, I venture to think, be all the more interesting inasmuch as a similar experiment appears to have been made in the United States with unsuccessful results. "Camels running wild in Arizona and being hunted and killed by the settlers to prevent their stampeding the stock in the territory,"—this was an item of intelligence that I read lately in an American newspaper with interest not unmingled with surprise. I am not in full possession of the facts, but I believe the camels in Arizona above referred to were turned loose about three years ago with the idea that they should become naturally acclimatized, multiply their kind, and prove in course of time a useful addition to the fauna of the country. From the mere turning loose of the camels, which in other parts of the world thrive and breed in the domesticated state, I should infer that the experiment of utilizing "the ship of the desert" in Arizona had proved a failure. The similar venture in Australia has had widely different results, and this article may serve a useful purpose in enabling those who have interested themselves in the Arizona experiment to discover the difference in original conditions or in management that has led to failure in the one case and to success in the other.

So far back as the "sixties," Sir Thomas Elder, who has been one of the most far-seeing, courageous, and liberal-handed men in Australia in introducing thoroughbred horses and valuable breeds of cattle and sheep, made the first experiment in the importation of camels. The venture proved only a qualified success, for heavy financial losses were incurred through a large proportion of the animals dying, soon after their arrival, from a virulent form of mange. However, the survivors of the original herd introduced became thoroughly acclimatized, and have continued to do good work at and around Beltana Station, of which Sir Thomas is chief proprietor. Moreover, they have bred freely, and the young stock have shown themselves in every respect superior to their progenitors, thereby proving the suitability of the soil and climate for the camel race. This last fact, aided by a variety of circumstances, has caused renewed attention to the camel question during the past decade, and the importation of further drafts is now going on upon an extensive scale.

Among the conducing causes referred to is the discovery of water in far-back regions and the progress made in artesian boring. This has resulted in a country formerly deemed useless being opened up for pastoral occupation. But this last achievement has

PASTORAL COMMISSION ON CAMELS PASSING LUNKE RUIN.

been rendered possible solely by the use of camel transport, for there are no railways and no possibility of making railways pay through these vast unsettled tracts, and furthermore there are absolutely arid areas intervening across which bullock teams and horses cannot travel. The only means therefore by which supplies can be taken to the settlers and their wool produce brought to the ports of shipment is camel transportation. A second, though a minor cause is that even in districts where there is no great stretch of waterless country the bullock-teams which have heretofore conducted the necessary traffic are in the hands of one of the strongest trade-unions in Australia, and the men controlling the labor organizations have on many occasions utilized the carriers as an all-powerful lever to extort terms from the pastoralists by proclaiming a boycott against the stations. This has impelled the wool growers to look around for means to render themselves independent of the bullock carriers, and in consequence a number of them have joined in the importation of camels and will for the future utilize camel caravans in country formerly traversed by bullocks. A third stimulating factor has been the discovery of rich gold reefs in the interior, the machinery for developing which can only be got to the fields by means of camels. Hence the renewed activity in the importation of the hump-backed animals, which are now represented by thousands where less than five years ago there were only hundreds.

To give an idea of the magnitude of the business, I may mention that in December last there were 500 camels undergoing the three months' regulation period of quarantine at Port Augusta, further drafts of 1000 were on their way to the same port, and orders for the purchase of still another 1000 were being executed in Rajputana, Kattywar, Beluchistan, and Afghanistan, whence the supplies of camels for Australia have nearly all been drawn. Contracts have also been signed for the introduction of still further drafts. In December it was computed that there were 3500 camels then actually landed in Australia, so that it will be seen that during the next two years that number will be increased up to at least between 6000 and 7000. All the camels in Australia are of the one-humped species, this having been proved to be the more suitable kind for the requirements of the country.

The disease known as the camel mange, ever-present among the beasts when in northwest India, seems to develop into an aggravated form when they first land in a new country. However, observation and veterinary skill are stamping out the scourge in Australia, and after the animals get over the initial attack careful attention secures them from further trouble from this source. No animal is allowed out of quarantine until it has undergone the test of three months' residence and has been subjected to the most careful examination. The camels at work throughout the country are absolutely free from the disease; hence the paramount necessity of blocking the infected animals.

When the camel is once acclimatized, all that is needed is careful tending to safe-guard it from any recurrence of the complaint. The animals thrive wonderfully upon the natural shrubs of Australia,—salt-bush, wattle, mulga, acacia, and other varieties. They wax fat especially upon salt-bush,—a plant that is likewise eagerly devoured by cattle, sheep, and ostriches. The eucalyptus trees also supply them with suitable provender, and they are tall enough to reach feed of this class which horses and bullocks, even if they would eat it, could not crop. Curiously enough, the camel never eats grass unless absolutely driven to do so by hunger; the foliage of shrubs and trees appears to be its natural provender. I have said, incidentally, that the young stock bred in Australia are superior in all respects to their parents. The reason for this is not hard to

CAMEL CARAVAN LADEN FOR A SOUTH AUSTRALIAN STATION.

find. In India and Afghanistan indiscriminate breeding is invariably the order of the day. The oriental mind shrinks almost with horror from the application of the principle of castration to any species of domesticated animal. Hence the poorest and weakest sires get stock as often as the large-framed and the strong. In Australia, where the breeding of sheep so as to add a penny per pound to the value of the wool upon a whole flock has been reduced to a science, a very different plan is followed. The camel sires are carefully selected, and the residue of the males castrated in early youth. Hence it results that the young stock grow up larger in frame, sounder in wind and in limb, and possessed of greater weight-carrying capacity than the animals originally imported. An Afghan importer named Abdul Wade said in the course of conversation with me at Port Augusta :

"When I go to buy camels in Afghanistan for Australia, of every twenty I see, nineteen are no good. Only one in a score is worth taking away. Here, every one of the camels you Englishmen breed is good, and many of them are finer than the very best to be found in all Asia."

This Abdul Wade is a large owner of camels in Australia, and holds a number of big station contracts for the transport of stores and wool. So I drove the point of his own remarks home with this query :

"Then, as you admit the excellent results to be derived from the principle of selection, I presume you will yourself act upon it in the management of your camels?"

For a moment his brow clouded, and I could see the innate prejudice of his race struggling with the practical learning he had acquired in a new country. But Abdul is a man of enlightenment and of broad-minded views, and his face speedily cleared. "Yes," he replied, after this show of momentary hesitation, "I admit you Englishmen are right, and I will follow your plan of breeding."

The young camel can be used for pack- and draught-work at three years of age. It grows up to ten years, and lives forty years or more, working all the while. Indeed, constant steady work is essential to their health, and, unlike bullocks or horses, they never require to be turned out for a spell, this, indeed, proving detrimental to their condition. The value of the camel varies with the sex and the qualifications of the animal. A fleet-footed dromedary, or riding camel, will fetch up to $500. A good average pack- or draught-beast is worth from $200 to $250. The cow is always

PASTORAL ROYAL COMMISSION ON THEIR JOURNEY ON CAMELS IN SOUTH AUSTRALIA.

PASTORAL COMMISSION IN NIGHT CAMP.

valued at from $25 to $30 more than the bull or the bullock, insomuch as the yearling calf at her foot is worth not less than $75.

It will already have been gathered that the camel is utilized in Australia for three distinct purposes,—as a pack-, draught-, or riding-animal. Most of them are used as pack-carriers, and a fair average load is 550 to 600 pounds, with which they can travel twenty-five miles a day for two months at a stretch. Individual camels can carry heavier burdens for a shorter spell, and the plan adopted on the march is, when any particular load is necessarily from its nature over-weight, to change that burden day by day, each of the strongest animals taking it in rotation. When the camel is used for draught purposes, he may be driven in a light vehicle in single or double harness. During the hot season, a considerable amount of work is done by the postal authorities in the northern regions of South Australia, mails being collected and delivered by camel buggy. The animals may also be yoked to a wagon in a team of eight or fewer, a high curved pole and a modification of the horse collar being used in this case. The wheels are provided with broad tires, and in this way heavy machinery can be transported over the desert. The riding camel, or dromedary, is used by the police, and also by station-managers when urgent messages have to be

WINNICKE'S DEPOT, MACDONNELL RANGE.

CAMELS IN THE DESERT OAK FOREST, IN SOUTH AUSTRALIA.

sent to the centers of civilization. These fleet animals will traverse over 100 miles per day for a week at a spell, and at an emergency have nearly doubled that record in a single period of twenty-four hours. An offender on horseback fleeing from the police has no chance against a constable mounted upon a dromedary, and the South Australian police have many exciting stories on record of feats of this class performed by members of the force. Government parties engaged in telegraph construction work have with them at one and the same time draught-wagons, pack-camels, and riding-dromedaries. Surveying and exploring parties dispense with the draught animals. The transport of stores and wool to and from the stations is done mostly by pack-camels, the compressed wool bales being made smaller than the usual size, so as to permit of a full load being slung in two equal portions on each side of the beast. For the transport of machinery, furniture, etc., the draught wagon is utilized. Managers of sheep stations also use the single-harness camel buggy to drive around the runs, inspect the stock, and visit the men upon the out-stations.

An overlanding caravan may be composed of twenty, forty, or even up to eighty animals. The headman in charge, if a European, rides upon a dromedary. There is one Afghan attendant for every

SOUTH AUSTRALIAN ABORIGINES SURPRISED BY A CAMEL TRAIN.

eight beasts, and he either walks or rides upon the load carried by one or other of his team. The young camels follow the caravan, and, showing the wonderful hardihood of these creatures, a four days' old calf has been known in Australia to travel twenty miles in a single spell, keeping up with the caravan all the time. These men seem to understand and to be understood by their charges, thoroughly. They speak to them in Pushtoo, the language of the Afghans, and even kiss and fondle them when loading or unloading. The Afghans come to Australia under a three years' contract. Their wages are about $15 per month, nearly all of which they save, as their employer supplies rations and their moderate requirements in the way of clothing, shoes, etc. This frugality in living raises the ire of the white bush-workers and the township storekeepers, and the Afghans are roundly rated at because they take nearly all their earnings out of the country at the expiry of their contracts. But there is another way of looking at the question. Suppose a Pathan camel-driver saves $500 during his three years of service, and takes away with him that amount to his native country, where it serves him as a handsome provision for the rest of his days. The $500 is not lost money to the country, for his labors have added probably ten or twenty times that sum to the wealth of the country in which he has worked. The prejudice, therefore, of the white man against the Pathan is unjust; moreover, it is quite open to the former to enter upon the work and secure ordinary white man's remuneration for his services if he proves himself competent in the management of camels. Indeed, with breeding systematically conducted in Australia and the animals brought up from youth among white men, there is every likelihood of the Pathan driver being eliminated altogether in the near future in favor of the Anglo-Saxon, who, in this line of life as in every other, is sure in the long run to beat his dark-skinned competitor at the latter's own calling.

But to show how necessary it is for the white man to receive instruction at the present stage from the oriental, I have only to cite the nose-peg by which the animal is led. This is an Arab-device, the origin of which is lost in the obscurity of ages; and for the purpose it is intended to serve it is a contrivance of rarest ingenuity. The nose-peg is for all the world like a chess-pawn, and is inserted in the muscle of the nostril, the thicker end within and the point protruding. To the point is attached simply a loop of string, upon which the stout leading rope is fixed. The strength of the whole arrangement, be it observed, is simply the strength of the loop of string. Any sudden jerk, through fear or anger, breaks that, and the animal is freed from restraint without injury to itself. Its driver can then soon reduce it to obedience again, and a fresh loop of string repairs all the damage done. A ring in the camel's nose would be useless, for the animal, when frightened or enraged, would with a single toss of its long and powerful neck pull it through the flesh and permanently injure itself. The loop of string may seem a very weak medium of control, but, in the case of a camel once broken in, proves adequate to guide the docile animal from one end of the year to the other.

I have referred to the hostility displayed by the bush unionists of Australia to the Pathan camel driver. Perhaps even more bitter is their enmity to the Pathans and Indian Mussulmans of superior class who are at the head of the camel trade. I have already mentioned the name of one of these, Abdul Wade, and his personality is typical and remarkable enough to merit a description in some detail. Olive complexion like that of a Spaniard, sharp clear-cut features, rather prominent nose, keen eye, glistening white teeth, medium height, the firmly-built figure of a mountaineering race, and the natural grace and courtesy untinged with the slightest admixture of servility that distinguish the inhabitants of the north of India from the dwellers on the plains,—such is the portrait of Abdul Wade so far as words can paint it. We met at Port Augusta, and but for his voluminous white turban—the possession of which I envied him under the broiling sun—there was nothing to distinguish him, as regards garb and general appearance, from our party of Englishmen. Abdul's command of English I found to be perfect ; and as regards camels he at once became my "guide, philosopher, and friend," and during several days freely communicated to me the results of his experience. Abdul Wade is a native of the Quetta district of Afghanistan. He is not the pioneer Asiatic engaged in the camel traffic, but he early grasped its possibilities. He first landed in Australia with camels fourteen years ago. Now the extent of his operations may be guessed at from the fact that he is at present executing a contract to import 750 animals.

"After you have got out these 750, Abdul," I remarked, "what next ?"

"Then," he replied laconically, "I shall go back to Karachi and buy 750 more."

"But I have heard it said, Abdul, that the bullock team carriers have vowed to kill you for spoiling their industry."

"Ah!" he responded, with a smile, "I could not prevent them perhaps killing me, but that won't stop the camels."

There was a depth of meaning in these words, so characteristic of the fatalistic Moslem, that I fully gaged only when I had more fully mastered the camel question in Australia. The country is crying out for "the ship of the desert," vast regions must remain untrodden by the foot of man without its aid, and the doing to death of a single Afghan most assuredly, in Abdul's terse words, "won't stop the camels."

The aversion shown by the horse to the camel seems in many cases to be quite unconquerable. A rider may coax his horse up to close quarters with a string of camels, but at any minute the steed is liable to turn and bolt at full gallop, trembling and perspiring profusely. A few horses are different in their behavior, but timidity in the presence of camel's is the rule. Upon one occasion I was driving behind a horse and a splendid mule. The latter remained quiet, but the former, for fully a quarter of an hour before we sighted a caravan of camels, betrayed nervousness and kept his ears rigidly forward. He had *smelt* the camels long before we saw them. When we drove up carefully, he was evidently reassured by the stolidity of the mule at the other side of the carriage-pole, who seemed quite unconcerned at the presence of "the long nodding necks and gaunt swaying bodies of the huge hump-backed creatures going curtseying by," as the senior Kipling picturesquely describes a camel train. I asked a government stock inspector who had had great experience among camels whether the horse could be trained to become accustomed to camels.

"Very rarely, I think," was the reply, "if he once shows his fear of them. Some horses are all right. But each animal has its own work in Australia, and in this vast country need hardly ever see each other, so that the one need not interfere with the other."

The wonderful capacity of the camels to go for long periods without water is a qualification which constitutes their main usefulness in the arid regions of Australia. When the foliage of the shrubs upon which it feeds is green and succulent, the camel appears never to drink. The herd may be driven to water, but only the females with suckling calves drink. When its provender gets parched and dry, of course the animal partakes of water, but it seldom drinks more than twice a week, though the fluid may be constantly accessible. In ordinary caravan work a spell of seven days without water, and also almost without food, is not a cause for wonder. The driver before starting sees that the hump from which the animal draws its reserves of food is in good condition. After two days or so out the camel is readily made to drink its fill, and in doing so stores away in the honey-combed lining of its stomach water enough for many days. There are many statements on record in regard to the feats performed by camels, but few tests have been more thorough, and none have been more fully substantiated, than those afforded by the Elder exploring expedition of 1891–92, that penetrated many hundreds of miles into the so-called great Australian desert. I have in my possession an autograph statement made by Mr. David Lindsay, leader of that expedition, from which some excerpts may be given :

Previous to the 20th August, 1891, my riding camel had carried me for 20 days on 6 gallons of water. On the 1st August all the camels except my riding camel had a drink. On the 24th August they had their next drink. On the 30th they all had a full drink, and we left for the march across the great Victoria desert, having 42 camels, some of them carrying as much as 700 pounds weight. On the 1st September at 25 miles the camels had 2½ gallons of water out of canvas troughs. On the 4th a few camels had 2½ gallons each. On the 7th the remainder of the camels had about 2½ gallons each of dirty water. On the 25th, an interval of 18 days, at 400 miles, in the evening the camels had about 2½ gallons,—some only 2 gallons. The whole of that journey had been over sandy country, much of it very hilly and all clothed with spinifex, the feed being of the poorest and not sufficient for the large caravan. The weather now became very hot, and we made 137 miles farther, reaching an out-station on the 3d October. I allowed the camels only 6 gallons each ; then we traveled seven miles out to feed. I was afraid, if I allowed the camels free access to the water after such a length of time without, that it would have killed some of them. Next day traveled 17 miles and gave them 6 gallons each. Next day they were allowed to drink their fill. It is worthy of note that none of the loading was left behind, and that only one camel was done, he reaching the water one hour after the caravan. From the appearance of the camels I judged that in three or four days farther without water four or five of them would have knocked up, but am sure that the remaining 35 or 36 would have gone from 7 to 12 days longer. My riding camels did 620 miles in the 34 days, the caravan doing 537 miles, as the crow flies, which of course was really a greal deal more owing to the bushes and hills causing the direction to be somewhat winding.

It will be seen, therefore, that the animals had spells of twenty-three days and twenty-one days (some only eighteen days upon the latter occasion) absolutely without water ; that all the time they carried heavy loads and traversed long distances ; and that in the great majority of cases the limit of endurance had not been reached. This is what has been accomplished at a pinch during an exploring expedition, but of course in the ordinary transport-work of supplying stations or opening up gold-fields in Australia nothing approaching such endurance would be demanded from the animals, a week or at most ten days without access to water being the utmost privation they would be called upon to face.

The Pathan camel-driver in Australia is a stranger in a far land, friendless, misunderstood, misrepresented, hated, but withal cheerful and contented. He accepts his lot with all the fortitude of a Moslem, and he carries with him certain customs that remind him of his own country. After a long spell at caravan work in the interior, his one delight is to get down to the city of Adelaide, where his countrymen have built a mosque of somewhat imposing dimensions. Within the sacred precincts of this building such festivals as the Mohurrum or the Ramazan are observed with the same attention to detail as if the worshippers of the Prophet were in Bombay, Teheran, or Stamboul. During other times the exiles have another method of reminding themselves of home life. When any extensive caravan starts overland, among the number of the Pathan camel-drivers will be found a skilled musician, specially imported on account of his proficiency in manipulating the tom-tom and the Afghan equivalents of our fiddle and banjo. *Apropos* of this Pathan instrumentalist, I am reminded of an incident that happened to myself in one of the presidency cities of India. I had been present at a native festival, at which the night had been murdered by the screeching of pipes and the dull roll of tom-toms innumerable. As I was taking my departure, a native gentleman, who associated much with the English and was indeed a University graduate, remarked in all seriousness: "Well, there is at least one thing in which we natives of India excel the British. You cannot make music." And so, out in the Australian bush, I fancy not even a picked orchestra from Melbourne or Sydney could "make music" to please these Pathan camel-drivers.

THE FIELD OF DOMESTIC ENGINEERING.

By Leicester Allen, A. B., M. E.

UP to a very recent date the fact that an engineer of ability could find in the field of domestic appliances alone enough work to employ profitably all his energies, the exercise of a high degree of skill in it opening the door not only to competence but to fame, has been but dimly perceived. But those who first had the sagacity to devote themselves to the special engineering arts pertaining to the supply of light, heat, air, and water to buildings inhabited as dwellings or offices, or in which people assemble for business, amusement, or worship, are already enjoying, in most cases, a substantial reward.

To deal with an example, electricity had grown into a most important branch of domestic engineering in many other ways than mere illumination, although this is, and will long remain, the most important application of electricity to the comfort and luxury of mankind. Electric heating had not then reached, nor is it likely at present soon to reach, a stage of development that will render its importance comparable to the numerous and daily increasing minor uses of electricity in domestic economy. And unless the extended applications of engineering in modern office buildings, hotels, asylums, schools, hospitals, etc., are not considered as properly to be classed as "domestic," the interests of the trades named cover only a very small part of the total area in which engineering skill finds room for exercise in modern buildings. Hotels, asylums, schools, hospitals, and even prisons, are the permanent residences of some, and the temporary homes of a large number of their occupants; and in such buildings the application of engineering to the home life will be found to overlap into the territory of mechanical engineering, steam engineering, and hydraulic engineering, in the kitchen, the laundry, and the passenger-elevator; and even into the limits of pneumatic engineering in the steadily increasing applications of gas engines to the performance of various kinds of work in the culinary and laundering departments, and in the ventilation of buildings.

The scope of the term "domestic engineering," as applied to a distinct division of professional effort, is thus seen to be wide enough to tax all the ability that can be brought into it; yet there is reason to expect that this scope will be enlarged in the future, so as to include yet undreamed-of possibilities. The spirit of progress will never cease to demand more of the aid of natural forces in the performance of the world's work; and the supply is apparently unlimited. Human ingenuity directed by science will work greater miracles than have yet been wrought; and in these benefits all classes will ultimately share in greater measure than is now apparent to those who look upon the mere surface of human events.

The tendency of the times is to the creation of a distinct department of engineering practice that will go hand in hand with that of the architect; the two professions working in harmony with each other in the perfection of architectural construction, which no longer includes mere beauty of design, but demands the maximum of convenience, comfort, and utility, with the minimum of cost in maintenance and labor applied to cleaning and other operations needful to health, comfort, and refinement of living. To this department the name chosen for the title of the present article is entirely appropriate, though some other equally suitable may be chosen.

The architect in future will seek more and more the aid of specialists in the different branches of engineering named, because adequate consideration of all these details will be beyond the power of any single mind, if undertaken in addition to the already sufficiently onerous labors of architects in the active practice of their profession. And art will be the gainer when, in the design of buildings, that which is necessary on the score of utility is first well thought out and provided for, leaving the artistic incorporation of these things into the general design entirely unembarrassed by any contingency which may compel alterations. In a case wherein all the engineering appliances that are to be used are decided upon in advance, and their positions and the space that will be occupied by them has been determined, the architect is, at the outset, placed face to face with such definite limitations as will to a great extent influence his work; and he can scarcely fail to design more intelligently and artistically than if these limitations are dimly perceived, or perhaps left out of sight altogether.

The engineering specialist who would occupy this opening field of usefulness will need peculiar qualifications. It will not be enough that he is well instructed in the general principles of engineering, that he is experienced in the construction of the great variety of machinery now concerned in the domestic economy of such buildings as have been named, and could, if called upon, design any one of them and superintend its erection in a machine-shop. In addition to such knowledge, he must be able to plan for its arrangement in a proposed building in such manner as not to absorb valuable space that could be better occupied, and in such manner that all will be convenient and develop the highest utility possible under the circumstances. He will have to learn that all the limitations do not fall to the lot of the architect, and that he must cheerfully take his share of them. He will have to be familiar with the uses of every machine that must be provided for,—not merely in a general way, but also in an operative sense,—in order that he may not overlook the numberless practical points that are of great importance in the aggregate. A considerable, but brief, inconvenience, experienced only at rare intervals, will be much more patiently submitted to than much smaller inconveniences of daily or hourly occurrence. In arranging a laundry, for instance, he will have much the same kind of problem to solve as he would face in the planning of a machine-shop, or a factory for the production of a particular kind of goods. He will often be obliged to abandon precedent and rely upon his own unaided judgment in locating all the machinery, because he will find very few buildings exactly alike either in purpose or in their shape or dimensions. He, therefore, no less than the architect, will be compelled to adapt his work to new conditions. In arranging for cooking-appliances in the kitchen he will meet with the same limitations. A certain space of a certain shape can be afforded, and in this he will be obliged to place all the numerous paraphernalia of the cuisine, some of them involving the use of steam for boiling, others perhaps involving the use of gas as fuel ; and in addition to these the range, which is indispensable in the preparation of food on a large scale. Then there will be the water-supply for kitchen and scullery to be considered, and the arrangement of all these appliances in such a judicious order that the use of one thing does not interfere with the free use of any other. Obviously the domestic engineer of the future will have to add to the general qualifications now possessed a knowledge of the order and routine of domestic work, in order to acquire perfected judgment in providing for all its requirements.

But there is a narrower sense in which the term "domestic engineering" is still appropriate. The houses of the well-to-do are yearly requiring more complicated and elaborate outfits. Not only are such houses mostly warmed and ventilated by steam and hot-water apparatus, but they are lighted by electricity if favorably located, or by gas manufactured on the premises if remote from city gas-supplies. In not a few instances electric light is supplied by a special plant requiring a special attendant for its care, and such installations require the same grade of skill in their design and erection, as well as for their attendance while running, as is needed for larger plants, furnishing light from central stations in cities. This is the case with many seaside-resorts, hotels, asylums, and sanitariums, which retain in their employ engineers competent to take charge of the running and repair of all their machinery. These engineers in turn employ subordinates. The number of engineers so employed in every large city is daily becoming larger. Engineers of this class are much superior on the average to those who were once employed to take charge of steam-engines for manufacturing purposes. They are forced, in order to obtain and hold their positions, to know much more than was thought necessary for an engineer to know in former years to render him competent to take charge of a steam-engine. The steam-engine does not claim all the attention of men engaged in this occupation. They must bring to their task a practical knowledge and familiarity with pumping-machinery, with heating apparatus, with the machinery of passenger-elevators, with dynamos, and with electric lamps and wiring. I have often been impressed in conversation with such men by the extent of their attainments, and surprised by their theoretical knowledge. Many of them are competent to detect subtle errors in principles inadvertently made by those who have had far greater educational advantages. These, then, may properly be called "domestic engineers." As time goes on they will find it necessary to keep up with the procession, and they realize this fact. They are usually careful readers of engineering periodicals, and some of them are quite as competent to contribute to engineering literature, upon practical subjects, as many of those who have some reputation as technical writers.

Still another class of men are entitled to range themselves in the ranks of domestic engineers. Their work, though not of a conspicuous kind, is not on that account less meritorious, or of less moment as regards the public welfare. The large part of mankind live in comparatively humble dwellings, and in these are to be found the work of the domestic engineers now to be considered. These homes are usually the abodes of such as find it necessary to practise economy in all expenditures, and who, because they cannot afford to gratify all their wishes, must make the best of what they can get.

Expensive heating-plants and electric lighting are beyond their reach. There must be something cheaper, but it must not on that account be intrinsically bad. They will waive luxury, but insist upon comfort; and though they are willing to forego style in their household arrangements, they want what they have to be in accordance with sanitary requirements. For these have been invented, in the heating and plumbing trades, a series of devices as much entitled to be embraced in domestic engineering as the costly outfits of more ambitious dwellings. The amount of intelligence and careful study that has been brought to bear upon the subject of furnace-heating, and upon the construction of stoves and ranges that can be afforded at a moderate price, is known to few outside of the trade. And the success attained by these means of heating is such that it cannot be ignored by any one who looks at the subject of heating and ventilation with an impartial mind. While any such man will not admit that furnace-heating is to be preferred to hot water or steam, he will be compelled to admit that it is the best system of heating ever placed within the reach of people of moderate means. And if he pursues the subject into the intricacies of construction of these useful devices, he will be compelled to admit, also, that the same kind of careful thought and attention to fundamental principles has been necessary to bring the art to its present advanced state as has been essential to success in any other branch of industry.

The problems of good furnace-heating are not all general so that once solved for any particular case they are forever solved for any other possible case. As much depends upon careful adaptation of a hot-air furnace to the particular building in which it is to be used as is involved in the erection of apparatus for any other kind of heating. Things cannot be safely guessed at in any system of heating; and the most successful in the erection of warm-air furnaces, as well as in the erection of steam and hot-water apparatus, are those who do the least guessing. The rule of thumb finds no more appropriate place in heating and ventilation than it does in working out a strain-sheet for a bridge, or in running a line for a railway. In the art of ventilation, especially, the failures are to be mostly attributed to a departure from methods of calculation and construction that hold good in all engineering work. The omission to observe and strictly follow these methods, even in seemingly minor details, though it does not always result in failure, introduces the possibility of it, and nearly always results in a measure of inefficiency that could have been avoided by right calculation. Therefore the erection of such apparatus is engineering work whenever, even in the smallest installment, it is done in accordance with sound engineering principles.

The art of landscape gardening, so far as it relates to the improvement, beautifying, and irrigation of grounds belonging to any building in which people are housed, ranges itself under the inclusive title of "domestic engineering." This art, as a distinct profession, is of comparatively recent date in the United States, one of the earliest examples of it being Central Park, in New York city. But the systematic grading and adornment of gardens and grounds was practised long before Central Park was projected. The demand for such work, however, in its highest perfection was too limited in the earlier history of the country to encourage the practice of this art as a specialty. Now that the country has accumulated wealth, and the art sense of its people has been cultivated by travel, the demand not only for the highest type of architecture in buildings, but for appropriate artistic environment for such buildings, has opened an attractive field for the practice of landscape engineering.

Some have dreamed of a period of material and social progress when mankind shall be emancipated in large measure from toil; when a more equal distribution of wealth will prevail; and when a life of comparative luxury and ease will be within the reach of all those who now labor hopelessly to attain it; a period when "Man to man, the world o'er, shall brothers be and a' that." So dreamed that manly poet, Robert Burns; so have dreamed many others who have pictured the families of men dwelling together in fraternal association in large, cleanly, handsome buildings filled with and surrounded by all that makes life worth living. This dream of the future of the human race, whether chimerical or not, is always a peculiarly attractive one. Should such a period ever arrive, domestic engineering will rise to the first rank in the ameliorating influences which mitigate trials mankind can never wholly escape.

ELECTRICITY

Conducted by Franklin L. Pope.

THE most important event which has recently occurred in electrical circles was the International Congress of Electricians, which convened in Chicago on August 21, and was attended by several hundred delegates and leading electricians from all parts of the world. The veteran physicist von Helmholtz, of Germany, was elected honorary president, and Dr. Elisha Gray, of Chicago, chairman. The papers presented in the working sections of the Congress were for the most part admirable in their scope and treatment, and may be said to have fairly well covered the entire field of industrial electro-technics. The marked preponderance, both in number and importance, of the papers having reference to problems connected with the utilization of the alternating current is one of the most significant features of the occasion, and serves to bring out in strong relief the fact, which has for some time been patent to all thoughtful observers of the tendencies of the time, that the alternating system, in spite of the bitter and unscrupulous opposition which it was compelled to encounter during the first years of its employment in this country, is surely destined to be the system of the future. In fact, appearances indicate that the direct-current system of distribution, so far as central station work is concerned, has already been definitely abandoned, at least in the United States.

IN the course of the proceedings, a most instructive and interesting discussion took place in reference to the employment of alternating and polyphase motors for the transmission of power. Each of the three systems now in practical use—the direct-current, the alternating single-phase, and the alternating polyphase—found ardent advocates, but the discussion showed that the champions of the direct current were decidedly in the minority. The general consensus of opinion, especially among the European engineers, appeared to be that the simple single-phase alternating system is likely to become the system of the future, although the polyphase system found its strongest supporters among American engineers of extended practical experience. A prominent electrical engineer who holds an important position in connection with the Niagara Falls enterprise stated that bids for the apparatus to be used there were received from all the principal firms in the world, and that the estimates of cost for continuous current apparatus were in every instance largely in excess of those for alternating apparatus. The distribution at Niagara will be either by means of overhead conductors, or by bare wires carried in a subway. The latter system, however, will be very expensive, except for short distances. It is probable that overhead wires will have to be used, and that people will have to learn, by experience or otherwise, to keep away from them and let them alone.

THE illumination of the central nave in the Manufactures building at the World's Columbian Exposition is the most unique and magnificent example of electric-arc lighting in the world. Five great coronas, carrying 414 two thousand candle-power arc-lights, are suspended at a height of 140 feet from the floor. The space lighted is 1300 feet long, 368 feet wide, and 202 feet high.

THE retirement of Mr. Henry M. Whitney from the presidency of the West End Street Railway Company, of Boston, leads us to remark that to him, far more than to any one man, is due the wonderful revolution that has taken place during the past six years in the methods of street railway transportation by the application of electrical power. Starting with the nucleus of a comparatively unimportant line projected in the interest of a real estate enterprise, by his masterly policy he effected the consolidation therewith of all the conflicting street-railway interests of Boston, and, having the sagacity to see that the electric motor, though yet in a crude and undeveloped state, was destined to be the motive power of the future, he possessed the rare courage of his convictions which led him to test its merits on a scale hitherto unprecedented, and thus solved, by a single stroke, and for all time, the question of the commercial practicability of the electric street-railway for large cities. When the history of the commercial and social development of the nineteenth century comes to be written, the mark which has been made upon its records by Mr. Whitney will be found to have been both broad and deep. The vast industries which have grown up, as if by magic, in response to the urgent demand for electric transit in every city, town, and village of the United States, may be said almost to owe their very existence to his bold, energetic, and far-sighted policy, which created a market for their products that, in the ordinary course of events, could not have been developed for many years to come.

If it is possible, as we know from actual experience that it is, to construct a machine like a bicycle, which weighs only thirty or forty pounds, and will carry a person of four or five times its own weight over a road only moderately smooth, at a speed of fifteen or twenty miles per hour, with only an inconsiderable amount of wear and tear, why is it not equally possible to construct an electric motor-car, which runs on a smooth and well-surfaced track, in which the proportion of dead weight per passenger should be but little if any greater than it is in the bicycle? Evidently it is possible, and therefore it is worth while for some of our mechanical engineers to concentrate their attention upon the problem. The condition of the 90-pound steel rails, laid less than two years ago by the West End Company of Boston, gives conclusive evidence that the ordinary motor-car of to-day is far more destructive to the integrity of the track than are the 75-ton locomotives even at the high speeds of the steam trunk-lines.

A recent publication of the electrical statistics of Switzerland for the year 1891-92, states that there are in that country 1600 alternating and 1165 direct current lighting installations, nineteen power-transmission plants using 77 machines and having a total capacity of 2380 kilowatts; four electric street-railways, and three electrical mountain cable railways. In one of the power-transmission plants, 450 horse-power is transmitted 11½ miles at a pressure of 13,000 volts. The electrical engineering of Switzerland has for years been deservedly famous for its boldness, originality, and success. It is not unlikely that, thanks to its waterfalls and the skill of its electricians, this little mountain republic may in time become one of the principal manufacturing countries of Europe.

Returns for one year from the fire departments of sixty different cities in the United States, selected from among those having more than 20,000 inhabitants, show that the fires attributed to electricity constitute 1.19 per cent. of the aggregate number, and 1.23 per cent. of the aggregate losses. New York city heads the list with 59 fires, followed by Boston with 26. The generator capacity of the electric light and power plants now running in these cities, including central stations, isolated plants, and street railways, amounts to more than 200,000,000 watts, which is equivalent to nearly 4,000,000 16-candle power incandescent lamps, or 285,000 horse-power.

A model electrical kitchen has been fitted up in Boston by a concern engaged in the manufacture of electrical heating appliances, which presents many features of interest to the householder. In the left-hand corner is a vertical boiler, which supplies hot water to a sink in the right-hand corner. Next to the heater is an oven, in which a number of different dishes may be cooked simultaneously in the two lower compartments, while the upper compartment forms a hot-closet. On top of the oven is a broiler, which in a few minutes will cook a steak or chop to perfection. In the center is the range, consisting of a chest of drawers with a slate top, having a capacity for half-a-dozen different cooking utensils, and above this is a switchboard, with plugs and flexible cords, by which electrical attachment is made to such utensils as are required to be heated.

In a recent lecture before the Franklin Institute, Nikola Tesla stated that so strong had become his conviction of the possibility of the transmission of intelligible signals and perhaps even of mechanical energy to any distance without the use of conducting wires, that he no longer regarded it in the light of a mere theoretical possibility, but as a serious problem in electrical engineering which seemed to him certain to be carried out. He looks upon this result as nothing more than the natural outcome of the most recent investigations by himself and by others who have been engaged in the study of the phenomena of high-frequency alternating currents.

The incandescent light plant at the World's Fair is said to be capable of keeping 180,000 16-candle-power lamps alight at once, if required, which would be equivalent to the consumption of over 1,000,000 cubic feet of gas per hour. This is believed to be by far the largest single plant yet constructed.

Not many weeks ago telegraphic intercommunication between several of the principal business centers of the United States was nearly interrupted, and in some cases entirely so, by a heavy wind-storm, which prostrated the poles and wires in all directions to such an extent that a fortnight or three weeks scarcely sufficed to repair damages. This thing happens periodically at intervals of two or three years, and the public is beginning to inquire, with considerable interest, whether anything is going to be done about it. A well-known wise and witty engineer once summed up a discussion which had been going on for some months in the technical journals as to the cause of the breakage of railway rails, by observing that the obvious reason was that they were not made as strong as they ought to be. The fact that among the general wreckage of overhead wires those of the long distance telephone usually suffer but little in comparison with those of the telegraph companies is suggestive of a similar explanation. The real difference between the two is that the telephone lines are constructed by trained engineers and the strains are scientifically adjusted to meet the conditions likely to be met with, while those of the telegraph companies are planned by men often but little if any above the grade of ordinary day-laborers, and so, when an unusual storm occurs, they go down. Who ever saw a Western Union telegraph-pole, on a railway or in a country district, on which the cross-arms were accurately parallel to each other, and exactly at right-angles to the pole? Who ever saw one provided with iron braces to maintain the parallelism? But something more is needed than even good engineering before we shall have a satisfactory telegraph service which can be absolutely relied on at all times, and that is a radical change in the system of construction of the principal trunk-lines. Underground cables, of say five conductors, should be laid between all the principal commercial cities of the United States. The expense of these would not be excessive, and then we should always be sure of being able to use some wires, even under the most unfavorable conditions. The commercial public ought to insist upon this reform being carried out. It is conceivable that circumstances might occur which would render a complete interruption of telegraphic communication between our principal cities as disastrous a thing as could possibly happen.

Professor Ewing thinks that chemical analysis is a very imperfect means of estimating the magnetic qualities of the iron used in the cores of dynamos and transformers. Manganese, which is so essential to the strength and toughness of ingot iron, is most deleterious to its magnetic qualities. While much attention has been paid by electrical engineers to the design and proportions of transformers, but little appears as yet to be accurately known in respect to the material which mainly determines their efficiency.

THE returns of the American Bell Telephone Company for August show a net decrease of 2435 in the number of instruments in use. This is one of the results of the financial stringency.

THE hackmen of Toronto are delighted that the citizens of that municipality have voted, by a considerable majority, not to permit the street-cars to be run on Sunday.

THE utilization of water-power by electrical transmission bids fair to make Switzerland, at no distant day, one of the leading manufacturing districts of the world. Her electrical engineers were the first to demonstrate the practicability of electric power-transmission in large units under commercial conditions, and the abundant opportunities for utilizing excellent water-powers at a comparatively moderate outlay for hydraulic works have greatly stimulated the progress of the electrical industries in that republic. At the end of 1892, according to Professor Desler, of the Zurich Polytechnic School, there were in operation 552 electric-light installations; 52 plants for the electrical transmission of power; 121 storage-battery installations; and 1056 dynamos and electric motors. The number of arc lamps is 9746, and of incandescent lamps (presumably reckoned on an 8-candle-power basis) 115,926.

WE agree with the *Electrical Engineer* that there is altogether too much noise made by the electric street-car gong. Used so continually as it is on most of the existing lines, it loses all its efficacy as a danger signal, to say nothing of the intolerable nuisance of having a new and vehement variety of racket superadded to that already existing in the streets of our American towns, which had already earned the unenviable distinction of being the noisiest in the known world. Why not use a continuous, but not very loud "jingle-bell," like that of a horse-car, and reserve the gong for occasions of actual and imminent danger? There are times when the gong is necessary, but they are comparatively few.

THE Ohio State University has conferred the degree of Electrical Engineer upon a young woman, who is said to have stood at the head of her class all the way through, and who upon her graduation was offered and has accepted a responsible position with one of the leading electrical manufacturing companies. There is really no reason why many of the branches of electrrical engineering might not be carried on as well by women as by men, and indeed there are many processes requiring so high a degree of skill, dexterity, and unwearied patience that the characteristic mental and physical endowments of woman would seem likely to give her a decided advantage.

WHEN a bolt of lightning strikes into a mass of sand, it sometimes fuses the silica in such a manner as to form a tube of glass. Such a formation is termed a fulgurite, and specimens are said to have been found as much as thirty feet in length. Fulgurites occur in great abundance upon the summit of Little Ararat in Armenia, which is composed of soft porous rock. Blocks a foot square have been obtained from this locality, perforated in all directions by little tubes lined with bottle-green glass formed from the fused rock. A fulgurite found in Maryland, and recently examined by the writer, was something over a foot in length, and about three-fourths of an inch in internal diameter. Specimens have been found which were three inches in diameter.

A VERY interesting experiment has been made by Mr. W. H. Preece on the transmission of electric signals through space without wires. A heavy copper conductor was suspended on poles for a distance of 1267 yards along the shore of the Bristol channel. On an island 3.1 miles distant a gutta-percha-covered wire 600 yards in length was laid. Through the shore circuit an alternating current of 150 volts and a maximum strength of sixteen amperes was transmitted, which could be broken up into signals in the usual way by means of a Morse key. Telephones in the secondary line were used for receiving instruments. No difficulty was experienced in reading the signals at this distance, but, when tried with a wire laid on another island at a distance of 5.35 miles, though signals could be perceived, intelligible communication was found to be impossible. Mr. Preece finds it essential, to insure good results, that the secondary wire should be of a length at least equal to the distance between it and the primary wire. The system therefore fails to provide for the cases of isolated lighthouses and lightships, where such a means of communication, if practicable, might often prove of the greatest value. Experiments are now in progress to determine whether this principle is available for indicating the approach of a vessel to lighthouses and landfalls, but no results have as yet been made public.

A SUBMARINE cable has recently been laid between Scotland and Ireland by the British Post-office Department, by means of which direct telephonic communication has been established between Glasgow and Belfast. No facilities are given, however, by which exchange subscribers can be connected with the line, and hence it is necessary for two persons desiring to converse to make an appointment beforehand by telegraph, and then, at whatever inconvenience, to betake themselves to the central telegraph-offices in the respective towns at the particular hour agreed upon. This is a fair sample of the kind of accommodations that we would be likely to get if the telephone system in this country should be turned over to the government which many persons have been convinced by the newspapers it would be a good thing to do.

A LARGE underground telephone cable was removed a few weeks since from a conduit in Brooklyn, the lead covering of which had been completely destroyed by electrolysis due to the strong return currents of the electric-railway circuits. It is much to be feared that this is only the beginning of one of the the most serious difficulties which the electric-railway system will be called upon to encounter.

IT is said the introduction of the electric railway in Ottawa, Ontario, has brought about a reduction of several hundred in the number of horses kept within the city limits. This information comes from the officials of the water-works, who are probably in a better position to know than any one else, as it is customary to make a special charge for water for each horse kept by their consumers. The number of licensed hackmen in the city has fallen also, from 195 in 1890 to about 100 the present year. It costs nearly $200 per year to keep a horse; so it is evident that the electric railway is saving considerable money to the citizens of Ottawa. If things keep on in this way for another century, one will be compelled to visit a menagerie, or a zoological museum, if he wants to see an actual horse.

THE rigid enforcement of the Edison incandescent-lamp patent by the courts, and the disinclination of the management of the General Electric Company, its present owners, to enter into any arrangement to permit the lamp to be manufactured on a royalty basis by others, has had the effect of stimulating the inventive capacity of the electricians employed by rival interests, with the result that at least two new types of lamp have been put upon the market, which apparently bid fair to be commercially successful, while it is, to say the least, extremely doubtful whether the courts will pronounce either of them to be infringements of the patent. In one of the new lamps the neck of the globe is closed with a separate stopper, instead of being formed integrally, as in the Edison lamp, and in the other a fusible cement is made to serve the same purpose.

ARCHITECTVRE

Conducted by Barr Ferree.

NO apology is needed for the unusual amount of space World's Fair matters have occupied in these pages during the last two months and the present. The World's Columbian Exposition is the most important topic now before the American people, barring, of course, the financial troubles, and it is thus eminently proper that it should be here considered in all its architectural aspects, meanings, and significations. But there is a stronger reason than this that necessitates the amount of space we have given to this subject, and that is that the architectural publications of this country have been notoriously derelict in publishing reports on such questions and phases of the Fair as especially pertains to their scope. Architectural journalism in the United States is not a thing of joy to the profession, and it has more than once proved itself deficient in things where it should have done better. But it must be confessed that in the matter of the World's Fair it has shown itself thoroughly unpatriotic both to the country and to the profession. Its duty to the latter certainly does not begin and end with the publication of photographs. One exception may, however, be mentioned: our lively western contemporary *The Inland Architect* has begun the publication of a series of articles on architecture at the Fair, and is thus doing a work no other publication of its class has undertaken. We feel, therefore, that we may be doing a not useless work if the architectural side of the Fair is reviewed here in all its relations, for it is a work that has not yet been undertaken in this country. The popular magazines have exceeded the professional journals in the amount of space given to the Fair, although not all of this is architectural, nor is all of it in line with common sense or truth. The most important effort to illustrate the Fair completely is unquestionably that of *The Cosmopolitan,* whose World's Fair number is a miracle of illustration, and is by far the most satisfactory popular treatment of the subject we have seen, so far as the pictures are concerned. These are extremely numerous and of great beauty; the text is not so successful, being more heterogeneous contributions from great names than a serious undertaking to treat the Fair as a whole. Several technical papers have treated of their specialty at the Fair. One of the most interesting series we have seen is that on iron in *The Iron Age* (New York). The best architectural account is the series of papers appearing in *The Builder* (London), very complete, very just, and very appreciative.

THOUGH it is most natural, in considering the structural architecture of the Fair, to devote one's attention to the main buildings, the minor buildings—those built by the different States, foreign countries, special exhibits, and the like—greatly exceed the larger ones in number and variety. These latter structures have not yet received the attention they should have, for, even if many of them are of no special architectural importance, they teach lessons, negative as well as positive, that should not be ignored. The most notable article on the State buildings that has appeared is that by Mr. Montgomery Schuyler in *The Architectural Record* for July-September. This was evidently written in the early days of the Fair, since it does not attempt to cover all the buildings, and the illustrations that accompany it are from drawings, not from photographs. But the article itself is extremely well written and is in Mr. Schuyler's best style. It would be an easy matter, were we to try to cover the whole field, to begin the study of the State buildings by the process of elimination, dropping out the most insignificant, and continuing the operation until only the good remained. The chief drawback to this would be that there would be very little left. The New York State building stands preëminent by reason of its palatial luxury and general magnificence, quite in keeping with the wealth of the Empire State, but one cannot but regret that the leading State of the union is represented by a building that is so manifestly based on another building in a foreign country. Massachusetts can take greater satisfaction in its reproduction of a colonial mansion, which adequately represents it in character and in architectural strength. Pennsylvania has tried the effect of using the tower of its most sacred edifice—Independence Hall—as the chief motive of its design, and with fair success, though neither the tower of Independence Hall nor the hall itself is an architectural work to be admired for anything save its historic associations. But at least we may be thankful that the Philadelphia City Hall was not taken as a *motif*. California has unquestionably the most successful State building, the style—that of the early Californian missions—being at once typical and suggestive. It would be a most rash procedure to group the remaining buildings—an almost infinite number, if such an impossible comparison be permitted—into a single lot, and dub them "unnoticeable," but the fact is that many of them are very mediocre, and even when they undertake to be typical a great many only try to do something they cannot.

At first glance it might appear to be the bounden duty of every foreign country and separate State to provide itself with a building thoroughly representative and characteristic. But this was manifestly impossible in the case of the American States, so many of them having practically similar characters and products. With foreign countries the case is somewhat different, because with them the opportunities for independent growth were much superior. Yet several of the foreign countries have erected buildings that might as well belong to any other country as the one they are especially supposed to represent. The Brazilian building is a good instance, a florid Renaissance structure that suggests Brazil only because the Brazilian flag floats over its roof. It is certainly not less French than the French building itself. This latter is an ingeniously arranged little structure, very interesting and admirably expressing its purpose. The German building is unquestionably the most characteristic of the structures built by European nations. And it is also abominably ugly. Still it adds to the festal variety of the show, and notwithstanding its aggressively German character is a welcome addition to the structures upon the Fair grounds. The Swedish building is another edifice that has little artistic beauty to excuse it. What its relationship to Swedish national architecture may be we do not know; but it certainly achieves its end if that is the making of a striking building. The most objectionable part of the design is the huge central feature that strides over the centre. India has a rather charming little bazaar, not very large, and rather tinsellish in effect, but thoroughly characteristic and thus, on the whole, satisfactory. The most pretentious of the foreign buildings is that erected by Great Britain, and known as "Victoria House." It is pretentious, not on account of its size, which is less, we believe, than that of the German building, but because it has been built of brick, stone, and wood, and is intended to be permanent. In this particular it enjoys a great advantage over the other buildings, though brick enters into the construction of the Swedish building. It is a very well meant effort to reproduce an English country-house, and, while no one could, for a moment, mistake it for what it is intended to be, it is a very close approach to its prototype. Apart from this fault—of setting out to accomplish something practically impossible of accomplishment—the building is a careful piece of work and well merits study. Its situation, with the surface of Lake Michigan as a background, is especially happy, and adds much to the effectiveness of the architecture. Many lesser foreign countries have individual buildings, few of which call for special mention. Economy in such structures is not to be deplored, since building a house in Jackson Park was an expensive operation, and the smallest, roughest structure is so thoroughly sufficient as an expression of good will as to render it unkind and unnecessary to find fault because there are not a dozen Victoria houses instead of one. The function of the foreign buildings is not very clear, and in most instances they have helped to add to the confusion of the classification by being used to house exhibits. This makes the building, no doubt, more useful than if used as headquarters only, but it materially detracts from a symmetrical Exposition arrangement.

UNDER the general head of building materials and appliances a variety of exhibits are distributed throughout the Manufactures and Liberal Arts building. Doubtless all of these are arranged on a legitimate basis of classification, but the architectural student is put to a good deal of hard work in looking for the objects touching upon his profession if he would see them all. The foreign exhibits are apparently more insignificant in this department than in any other; certainly it would be difficult for them to be less in quantity and quality. With the exception of a few displays in Belgium no foreign country makes any pretense of building displays. The most notable feature of the Belgium display is that of the Vielle Montagne Zinc Co., located near Liége, Belgium. The company makes a very complete display of their zinc roofing plates, showing models of construction, etc. Roofing materials are also well shown in the American section, chiefly metallic roofing, though a few firms show roofing tiles. These exhibits are generally arranged in the form of model houses, showing the products in practical application,—a most useful idea, though the architecture of the booths is, as a rule, very bad indeed. It seems scarcely necessary to refer to the individual characteristics of these displays, since most of the goods shown have been upon the American market for a number of years past, and their qualities are thus well known to American architects. On the whole this section of the exhibition, though not numerously filled, may be termed tolerably complete. Some few exhibits of bricks and artificial building materials are shown in the same building. A very fine exhibit is made by the Hydraulic Pressed Brick Company, who have built a series of alcoves or pavilions, showing their products in all grades and colors. This is one of the most tasteful displays in the exhibition. Several other brick-making firms have similar displays. All of them, of course, are in the form of erected constructions. Closely allied to these is the exhibit of the Pioneer Fireproof Construction Company, of Chicago, who have prepared a good display of their fireproofing materials, shown in practical application. No attendant was on hand when we saw this exhibit, and no information could then be had concerning it. This was not an unusual circumstance, since during the early months of the exhibition there was an amazing dearth of attendants. It seems astonishing that firms would spend thousands of dollars in preparing a display and then leave it alone unattended as though it was a thing to be ashamed of.

STILL confining ourselves to the Manutures and Liberal Arts building, the sanitary display is next in order. A very good line of water-closets is shown, some sinks, some bath-tubs,and some plumbing fittings. The most marked feature of this collection—and indeed the same thing characterizes all the sections touching upon architecture—is the absence of novelties. It is doubtless a source of considerable satisfaction to the manufacturer to be able to make an effective display of his products at a great international exhibition from his ordinary stock alone, without the extra expense of new and costly objects, but, when with this is shown the lack of new things, the beauty of the arrangement is not so obvious. It is quite true that business methods in America are such that the most startling thing becomes old in an incredibly short time, and our manufacturers lose no time in putting the newest things upon the market. But it does seem not unreasonable to look for a fair proportion of new ideas among the vast collections at Chicago; and yet, as a matter of fact, very few things are shown that the public is not already familiar with. This is what the manufacturer is content to rest his claim upon for an award of merit, and that is what takes him to Chicago and has induced him to spend his money in making a display there. It follows, therefore, that few novelties are to be found in the section of sanitation, so large a firm as that of Peck Brothers, of New York, contenting themselves with a line of stock goods. This in itself is very good and fine, and is the largest collection of the kind in the exhibition, but it contains nothing that has not been previously before the public. We are obliged to confess that, until we saw them at the World's Fair, we did not know that such a thing as a folding bath-tub, covered with plush and presenting the outward semblance, when closed, of an eminently respectable lounge, was upon the market. But the manufacturer of this product comforted us with the assurance that that was no disgrace, since his goods were not much used in large cities, being designed for country houses or for small towns. A portable bath-tub is unquestionably a great convenience and a most useful article of household furniture, but, when it is covered with blue plush and turned into a sofa when not put to its legitimate (?) use, it seems to us to lose very much of its value as a bath-tub and as a sofa. We do not wish to be unnecessarily harsh upon the gentleman who devised this most useful arrangement, but we confess we should like to hear some reports from those who are accustomed to bathe daily in a plush-covered tub, and especially some information as to the condition of the aforementioned plush after it had served as an adjunct for, let us say, a year's baths.

A DOZEN or so of the better-known firms supplying the American market make exhibits of bath-tubs, stationary wash-stands, and the like. Porcelain tubs are shown in considerable variety, though, after all, there seems to be small difference between the work of different manufacturers. The largest display is that made by the Standard Manufacturing Company, of Pittsburgh. They show, among other special features, a model bath-room, the walls and floor of which are covered with imported tiles, and which is supplied with all the requisites of luxurious bathing. The cost of this room, which is much larger than the average bath-room in the average city house, and which is supplied with simply the best grade of stock goods, is stated to have been $4000, and in these hard times this may be instructively compared with the shower-bath shown by the Peck Brothers that may be purchased for a little less than $600. The Standard Manufacturing Company also show what is said to be the largest bath-tub ever made. It is a replica of a dozen made for the Mormon temple at Salt Lake City, and is ten or twelve feet long and proportionately deep. Unfortunately no information as to the nature of the religious ceremony in which these twelve monster bath-tubs figure is given. The display of water-closets is perhaps more varied than that of the bath-tubs, though the number of exhibitors is not very great. Still the largest firms are represented, and several of the displays are well worth visiting. It would require much more space than can here be given to it to examine these exhibits critically, and hence we can only briefly comment on the more striking features. Of these one of the most ingenious is the sectional model of the water-closet made by the Sanitas Manufacturing Company, of Boston, which, by means of a glass plate, enables one to actually follow the system of flushing in practical use. More interesting, and, we understand, a genuine novelty, is the noiseless water-closet made by Norton Brothers of Chicago, and called the Norton Hermetic Seal Noiseless Sanitary Fixture. This is quite a long name, but it well describes a water-closet that flushes the basin in an absolutely noiseless manner. This is a feature that every householder will welcome most heartily, since the noise made by the modern flushing water-closet is one of its most serious drawbacks. A further collection of sanitary appliances and devices are shown in the Anthropological building,—so delightfully are architectural objects and subjects distributed throughout the grounds,—but a consideration of its chief points must be postponed to another time.

ANOTHER small collection allied to architecture may be found in the north gallery of the Manufactures and Liberal Arts building. From the exhibitor's standpoint the galleries have not been a success, nor is it much wonder, since they can only be reached by climbing high flights of steps, no elevators, by a gigantic oversight, having been provided for them. There is a dreary loneliness about these great galleries that would be extremely restful after mingling with the crowds below, were there greater seat accommodation whereon one might rest an exhausted body, for without an exhausted body it is quite impossible to see a thing at the World's Columbian Exposition. What we have termed the architectural section—which we believe it is called in the official catalogue—is no exception to the general loneliness. It includes a mixed variety of exhibits, such as paints, lathing, window apparatus, and similar articles, not very complete as a display, or very well arranged, but the best of its kind in the Exposition. This seems to be rather the miscellaneous department, where objects that could not be delegated to other sections have been placed. It is not, as has been said, an invigorating display. Nor, for that matter, is any part of the architectural subjects. When one thinks of what might have been done and what has been done, it is hard to resist wholesale condemnation of what may be seen. It is, of course, now too late to accomplish anything by bewailing the hard hand of fate, but, as we pointed out in the Magazine last month, the architect who goes to Chicago to learn professionally will find little but the buildings themselves and their *ensemble* to give him profit.

SEVERAL books and pamphlets are on our table awaiting acknowledgment and review. They may be hastily noted here reserving more extended notice, should opportunity offer, for another occasion. ——Messrs. Jones & Laughlins, Limited have issued a valuable little hand-book, entitled "Standard Steel Construction,"* a manual of beams, channels, and structural shapes, arranged by J. M. Larimer. Although put out as a catalogue of the firm's own products, the book contains a number of tables, compactly arranged, and is admirably adapted to the convenience of architectural engineers and architects.——Mr. George Hill, whose name is familiar to the readers of the Magazine, has reprinted, for private distribution, his admirable paper on "Modern Office Buildings,"† originally printed in the *Architectural Record*. We had occasion to notice this article—quite the most useful thing of its kind we have seen—when it first appeared, and need add nothing to what we said then save to commend it afresh to our readers. We must protest, however, against Mr. Hill's sub-title, "Practical Limiting Conditions in their Design." He has very little to say about design as it is generally understood. What he is most concerned with is planning,—vertical planning and horizontal planning; about the design of the façade he has nothing whatever to say. Had he used the word "Plan" in place of "Design" in his sub-title, he would have expressed his purpose precisely.——The catalogues issued by the Winslow Brothers Company ‡ of Chicago for the current year merit more than casual attention. Their Photogravure Edition is a sumptuous book, bound in cloth, and containing one hundred and forty-one photogravure plates of work executed by them. The plates are finely printed, and the volume is an important index to noteworthy recent work. Taken as a whole, the work of this company attains a high

***Standard Steel Construction*. Arranged by J. M. Larimer. Pittsburgh, 1893. Jones and Laughlins, Limited.

†*Modern Office Buildings: Practical Limiting Conditions in their Design*. By George Hill, C. E. New York [1893.] [Privately Printed.]

‡*Collection of Photographs of "Ornamental Iron."* Chicago, 1893 Winslow Bros. Co.

order of excellence, and their catalogues amply testify to the good work they are doing for ornamental iron in this country. ——The catalogue of the Berlin Iron Bridge Co. (East Berlin) also merits acknowledgment in this place. While chiefly concerned with the building of shops and warehouses, this catalogue may be profitably studied by every builder and engineer. It is amply illustrated with cuts of work in progress and completed.—— Our thanks are also due for a copy of a superbly gotten up book "Descriptive and Illustrative of the Equitable Building, Denver." This building we have previously brought to the attention of our readers, and we need only speak here of the care exercised in the making of the present volume. It is finely illustrated, chiefly from photographs, and is a handsome memorial of one of the finest business blocks in the United States. It is to be regretted that the text is not on a par with the illustrations and the work of the architects, who are Messrs. Andrews, Jaques and Rantoul of Boston.

We have deemed it our duty to refer, from time to time, to the architectural and engineering abominations of Chautauqua, not because we are not in sympathy with the Chautauqua idea, but because we deemed it proper to expose the atrocities of Chautauqua village. It is with more than usual satisfaction, therefore, that we find our views supported by no less an authority than Mr. George E. Vincent, who has contributed an article on this subject to a recent number of *The Chautauquan*. The idea of Mr. Vincent's article is to expound the increasing hygienic advantages of the village, and he apparently labors under the impression that the abominations that have characterized it to the present year of grace were essential to its future growth. Such would have been the case in any ordinary community. But Chautauqua is not ordinary; it was built and organized with the stupendous idea of providing education, and the very best education at that, for the multitude. It had at the very beginning, therefore, an educational purpose and value which no other town has had, and should have been planned in the most healthful and scientific manner. Had this been the case, it would not have been necessary for Mr. Vincent to chronicle, as he does, the destruction of sixty cottages by fire in 1887, ten years after the village was started, and then only to become aware that "wooden buildings ought not to be crowded indiscriminately together, and that, unless some adequate water-supply available summer and winter could be obtained, the whole town was liable to destruction." It does not speak well for any body of men, much less public educators, to have needed ten years to get these elementary ideas through their heads. Nor would one suppose, did not Mr. Vincent vouch for it, that a lot of "cheap and unsightly shops and booths" could ever have been burnt there. But these things belong to the past. More important is the regeneration of Chautauqua, which is the real text of Mr. Vincent's article. Gigantic improvements are under way, including a complete system of sewerage, which, *mirabile dictu*, will be ready for the present summer. Yet as it has taken sixteen years to reach this, though nowadays no ordinary town is started in which it is not the first and most important consideration, the Chautauqua people have no reason to accuse themselves of undue celerity in their movements. We must, however, differ with Mr. Vincent in his statement anent "the substantial and artistic" summer homes which have been built at Chautauqua since 1889. There were no buildings in the village in 1892 which could by any possibility be called artistic, though doubtless they were substantial enough. We regret to learn, also, that the Assembly furnishes plans and specifications free of charge to all who wish to build. This policy should be at once revoked if any permanent and artistic change is to be produced at Chautauqua.

RAILWAYS

Conducted by Thomas L. Greene.

IN this Department it is intended to cover more especially the financial, commercial, and operating portions of the subject indicated by our heading. When we consider how large this railway question is, how important in its effects upon the national prosperity must be the right solution of it, as well as the many details involved which bear directly upon so many different professions and trades, we are easily convinced that in its many-sidedness it is worthy of the particular attention of specialists as well as of the general public. The proper management of our transportation lines calls at different times for a wide knowledge of differing arts and sciences; and a discussion concerning them will show the many places in which such questions also touch other departments of human thought and work. As an instance, let us take the so-called industrial companies. Of late we have been rapidly developing a corporation civilization. Corporations are forming to do what firms and partnerships have hitherto done. These "artificial persons" bring new questions to the foreground, as, for example, in finance; yet, if we study the history of railways and particularly of the great systems formed by the consolidation of smaller roads, we shall find many of the modern industrial corporation problems anticipated, and probably also dangers pointed out and a path of safety indicated. Then, too, the public side of railways needs discriminating attention. We expect "regulation," but what should it be? In no other line of commerce does legislation affect so many, both investors and employés. What legislation is fair and just; what the results of such and such laws are likely to be; what further statutes we ought to ask for,—these questions concern thousands. The rate problem in its many ramifications reaches shippers and civil engineers alike. Then again the art of operating a railway, aside from mechanics, involves important questions of judgment and of progress, these in turn having their direct influence upon bond interest and dividends. The field is wide. To the end that this department may be of direct interest to the readers of the ENGINEERING MAGAZINE the writer would be glad to receive from time to time suggestions as to lines of thought and topics for discussion. He has no pride of opinion, but will strive to present the facts impartially, with such comments as may serve to bring the merits of the case into clearer light.

THE Chesapeake and Ohio is one of the first American roads to print the annual report for the fiscal year ending June 30, 1893. The road itself is an object lesson in railway management. Five years ago the present owners took possession of a property practically bankrupt, without good equipment, and in very poor physical condition. By the judicious expenditure of money, received partly from earnings and partly from the sale of bonds, the whole railway has been slowly brought to a good standard. This change in the rails, road-bed, and equipment has allowed of longer and heavier trains. As the traffic tributary to the road is almost wholly of low class, paying but little per ton-mile, the problem resolved itself finally into the question how much could be got into a train; for this freight, though "cheap," is not limited in quantity, coal and coke comprising about fifty per cent. of all the commodities. The greater portion of the coal is carried at the extremely low average rate of 3.27 mills per ton per mile. The average lading of each freight train has increased from 225 tons in 1890 to 283 tons in 1893, the latter yielding $1.44 average earnings per freight train-mile in spite of the low average rate. The seaboard coal is carried a little over 400 miles from the mines at about $1.40 per ton and still at a profit, though the cars are returned empty, because the construction and condition of the plant are of the best and permit the most economical operation. To the trained eye these few figures show a record which admits of praise. But it is worthy of study also as showing the lines along which it is more than probable the successful solution of the operating of railways in the United States will move for the future. The commercial conditions of the transportation problem may be said to be set in the United States. Low average rates we must accept as a fact. The payment of interest and dividends depends upon the carriage of large quantities at low charges, but still at a profit, because of low operating expenses per unit. This latter term does not mean small annual wages për man, but that by means of the best appliances a larger and larger volume of business can be moved without increasing expenses in like proportion. This in turn means the liberal but judicious expenditure of capital at all places—such as the reduction of gradients—where a saving in operating expenses can be effected. In the Chesapeake and Ohio case the increase in train loads has been accompanied also by an increase in the number of trains and in gross earnings. The whole history and experience of that company for the past five years are worthy of the attention of all interested in the solution of cheap railway transportation in the United States.

THE paper in the September number of this Magazine, by Mr. James L. Cowles, on "Distance not a Factor in the Cost of Railway Traffic," deserves discussion. There is no doubt that the managers of our railways make too much of distance in arranging tariffs. As Mr. Cowles says, there is no appreciable difference in cost of running a train whether full or half full. The study ought to be therefore to provide good loads, and in the practical working out of such study the length of a journey is not, or at least ought not to be, the controling factor; yet rather strangely it is difficult to make the average railway man abandon the old idea of fares arranged according to miles traveled. For an illustration we will say that commuters travel 25 miles to and from a city daily, while beyond the 25-mile limit of "short" trains lies a country desirable for residences but unoccupied. City men will not go there and pay double the 25-mile commutation. It is clearly for the interest of that railway to run express trains from the furthest section spoken of without stops within the limits already developed. The company should also charge a smaller monthly sum than the mileage proportion,—a sum not more than the city business man can easily pay. The result would be the building up of a steady suburban travel from a section which the mileage theory would keep unoccupied; and, as cost of terminals and tracks as well as bond interest is not increased, the earnings of these longer trains over mere movement expenses go to swell dividends. This very thing is done with milk, which is carried from all stations to the city at the same rate; why not more of the sort in passenger service? And so in other departments. The Hungarian zone system of tariffs, though not applicable as a whole to the United States, ought to teach us that our worship of distance is the worship of an idol. The arguments and statistics advanced by Mr. Cowles in support of this part of his contention ought to receive consideration from all railway managers and traffic men.

IT is to be feared, though, that the good points of the article will be lost sight of in the general disagreement on the part of railway men with the inferences and conclusions which Mr. Cowles draws. To say that distance should not control rates is one thing; it does not follow that distance can be eliminated from the problem altogether. In the first place the figures quoted do not always bear directly upon the question. For example, it is said that the load of the average passenger train is but 41 passengers. A more correct way of putting the fact would be that the number of miles traveled by passengers is an average of 41 for each train mile; not a high average, to be sure, but one which throws little light (except as a hint for further examination) upon the question of train management. But the fundamental assumption of those who would apply the principle of the post office to transportation and charge each passenger or each ton a uniform rate regardless of distance carried is that the present average will continue to be the average under changed conditions. Averages have their uses, but we must remember that after all they are abstractions. Perhaps no train carried just 41 passengers; some had more and some less than that number. Now, the average fare paid per trip by each passenger in 1892 was about 50 cents, though many paid less than that and a few paid over a hundred dollars. Let us suppose 50 cents made the fare for all without distinction. The number of those who had been traveling short distances at 25 cents a trip would diminish, while the trains for long distances would be crowded. The average, on which the whole calculation depends, would be at once destroyed. Unfortunately, while loads do not affect train expenses, distance does. Fuel, enginemen's and trainmen's wages, repairs, and the like vary directly with the miles traveled. Practically therefore the passengers who paid but 50 cents for a trip from New York to Kansas City, let us say, would not cover those movement expenses, to say nothing of bond interest and dividends, though they might fill a long train. It is this distinction which Mr. Cowles misses when he says: "I have now demonstrated that distance costs practically nothing in railway transportation."

THE discussion now naturally leads up to the true principle in tariff-making, of which Mr. Cowles seems to have a dim impression. That principle is the old one, —to charge what the traffic will fairly bear. Take the passenger fares again. If we could ascertain what his journey was worth to each passenger and charge him that sum (of course within limits) for his ticket, we would fill our trains with travelers and our railway treasuries with cash. This would put distance just where it really belongs,—a factor, but not the controling one. A journey of twice the length is not necessarily worth twice as much to the passenger; this fact becomes all the more clear as we assume longer journeys; it lies at the basis of the Hungarian success in charging for 50 miles more than for 25 miles, but making nearly the same fare for 400 as for 300 miles. Of course this principle can never be fully carried out; but we are approaching it in various ways, by asking extra for a limited train and for a parlor car seat, by running (as in England) workingmen's trains, and by charging less in proportion for a through ticket if without the privilege of stopping over on the way. The difficulty is to keep high-priced travelers, who ought to pay well, from taking advantage of a cheap train intended for poorer men, since class distinctions are not favored in America. In the same way a classification of freight is intended to put a high rate on dry-goods in order that coal may be carried at a low charge, while yet the total revenue is the same. If dry-goods and coal were charged alike, the coal would not move. Now, the low average load for passenger and freight trains is not an argument for the elimination of distance altogether, but is an evidence that our railway managers have not yet solved the problem of apportioning tariffs in the way best suited to stimulate traffic according to the charge which each passenger or each ton may be expected easily and fairly to bear.

THE guaranty of the dividends on the Canadian Pacific shares by the Dominion of Canada expiring last August, the company must now depend upon its own resources for future dividends. In its last annual report the management professes to have no fear. Indeed, of late the company has distributed surplus earnings to shareholders in addition to the 3 per cent. guaranteed. Its cash balance records about $7,000,000 to its credit,—a showing very favorable as to the condition of its treasury. The company asked and obtained permission to issue preference stock to the amount of $8,000,000 for the construction of lines hereinafter referred to and for improvements—particularly bridges—on the main line; this stock carrying priority up to 4 per cent. in dividends. The Canadian Pacific was built largely through the bounty of the Dominion, in order to secure a transcontinental line connecting the widely-separated provinces. It is a bit startling to find this railway proposing to abandon for through traffic a large part (about 2000 miles) of its old line in Canada in favor of a new road through Minnesota and North Dakota, mostly outside Canada and within the United States. To account for such a change in policy further discussion is necessary.

To put the matter in a word at the outset, we may say that Canada alone cannot support the Canadian Pacific railway. The population of British Columbia and Manitoba, through which the railway runs for a distance of nearly 1500 miles, is only 300,000 by the census of 1891. The same sparseness of population follows the line of the railway to Ottawa and Montreal, about 2800 miles from the Pacific. In the more settled parts of eastern Canada the traffic is greater, but at the utmost not more than enough to support the lines located there. The business of Canada, while conservatively conducted, is not progressing. The future of Canada is perplexing her best statesmen, for, in spite of great exertions for immigrants, the increase in numbers and in volume of trade is slight compared with the United States. Statistics of production and export might be quoted to show what practical railway men will draw from the figures already given, that people so few in numbers cannot furnish traffic enough to support thousands of miles of railway, even though the company has had large grants of land and money, with exemption from taxation. Without permission from the United States government to carry traffic from points in the United States through Canada to destinations within the United States, the Canadian Pacific could not earn fixed charges. With the earnings from its own lines (local traffic) secure to it, additional traffic, in accordance with well known rules, is a clear gain, even though carried at low rates. Hence the complaint so common among American roads "that the Canadian Pacific has reduced rates just enough to get the business." The statutes of Canada allow of any discrimination or preference necessary to secure traffic from the United States. In some cases that company can compete successfully with American railways on even terms. It is also a fact that low rates on the Canadian Pacific are of benefit to certain sections of the United States—particularly New England and the Northwest—where any interference with the privileges of the Canadian company is naturally, though illogically, objected to; illogically, because we ought not to treat a Canadian railway and a Canadian manufacturer on a different basis. Transportation of United States goods through Canada is carried on under the system of bonding, the obligation of which, under treaties with Great Britain, is in doubt and which is often attacked as favoring Canadian competition as against American railroads, especially under the burden of the interstate commerce law. A curtailing of Canadian Pacific privileges in this respect, if carried out next winter as is now threatened, would affect that company's securities unfavorably.

THE spring and summer have seen an unusual number of important railways put into the hands of receivers. In most of these cases the companies acknowledged the correctness of the allegations of insolvency brought against them in the complaints, and thus turned the proceedings into friendly suits to secure the protection of the court. The whole matter of corporation receiverships has undergone great changes in recent years. Originally a receiver for any firm was appointed in order to sell the property and close up the business. The Court undertook the winding up in order that every creditor might receive his pro-rata share of the assets, whatever they might be. Thus a receivership implied a stoppage of business. It is our boast that commercial law changes as commercial customs change, though slowly and at a distance; for commercial law is but a crystallization of the commercial customs of the community. So, certainly, it proved in receiverships. Receivers were appointed for railways as well as for private firms. But railways cannot be wound up or stop running. They are under an implied contract with the public not to do that; and, being operated, the manager, no matter whether called president or receiver, must have a policy as regards rates, trains, and similar things. Moreover, a railway company cannot easily take backward steps; its receiver cannot allow creditors to seize some important part of its line because they hold an underlying lien, or permit another creditor to tie up equipment needed to fulfill the road's implied obligation to the public. Hence the logical outcome was that a company might itself plead for a receivership if it thought its interests endangered, or might consent to a complaint made through friendly hands. The late Mr. Jay Gould was the first to bring this doctrine forward, in the case of the Wabash railroad, and his contention was afterwards substantially confirmed by the U. S. Supreme Court. Since that time the theory of a receivership for a railway has gradually changed from the conception of a winding up to that of a kind of "protection" by the Court of the best interests of the company as a whole. Dismemberment of a system built up of various lines consolidated is thus avoided under stress of bad times. While it is a hardship for any bondholder to forego his bond interest and his legal rights perhaps at the time when he needs money the most, yet there is no doubt that it is better for him in the long run, while preserving as a receivership does, the unity of the property so essential to the operating of the road for the best advantage of the public at large. Hence, while a receivership for a railway is a confession of insolvency at the time, and is usually a surprise to those not well informed, yet it does not as of old mean a disastrous end, but a conserving of the property until times improve or a plan of reorganization can be agreed upon.

THE operating expenses of the Canadian Pacific have been so low as to invite comment. Its maintenance of way is under $500 per mile, a low average. Its cars and coaches do not cost for repairs as much as on older roads in the United States. It has been suggested that the usual expenditures have in reality been made and the money charged to capital. This cannot be true, though no doubt everything possible has been called an improvement; a better explanation being that items for maintenance and repairs are low now, but will be greater in the future when renewals become necessary. It is fair, therefore, to expect an increase in operating expenses. When we also consider the fixed charges which are increasing every year rapidly, we see how great must be the pressure for an increase in traffic to support the capitalization. If our reasoning be correct, this traffic increase must come mostly from the United States in competition with American railways. If anything—Congressional legislation for example—should check this increase, the Canadian Pacific would of course be affected adversely. In spite of its apparent injustice, Canadian railway competition with United States roads is now so firmly established that it is not likely to be broken off completely; it may, however, be subjected to more severe restrictions, together with some legal relief to the American rival lines. The Canadian Pacific is "playing for high stakes," a game whose hazards must make uncertain the outcome as to the continuance of dividends on the common stock.

MINING & METALLURGY

Conducted by Albert Williams, Jr.

AT the present time the main interest in mining circles is to guess at what is to become of the silver mines of the United States. Such of them as carry gold in appreciable quantities may be able to continue work in any event, using the gold as a mainstay and the silver as a by-product. Another class of so-called silver mines yield lead ores, which may run low in silver contents, and hence be used in silver-lead smelting for fluxing dry ores, or may carry enough silver, or silver and gold, to furnish a true precious-metal ore. Then there is still another class, the copper-silver mines, like some of the mines of Butte (Montana), which might rely upon the copper and handle the silver (of the copper-silver matte) as a by-product. Finally there are two or three, or three or four, mines so rich that they could have withstood any reasonable reduction in price of product. Altogether, silver-mining is not going to be entirely stopped, for there are too many mines which produce, in addition to their silver, either gold, lead, copper, or some combination of those ores, which will enable them to exist somehow. But the immediate outlook for silver-mining is indeed gloomy.

PROBABLY the best chance for the new crop of prospectors is to relocate some of the old and abandoned low-grade gold-quartz propositions, that would not pay in earlier times when all expenses of mining and reduction were so much heavier. The writer has in mind a big quartz ledge, on which a fatuous Boston company put a 60-stamp mill, sometime back in the sixties,—this mill being housed in a stone structure and to be trailed all along the road by the usual abandoned experimental machinery of those days. There was one fault with the mill. It had no water. To properly develop that mine would require building a narrow-gage railroad some 18 or 20 miles to a river. So far nobody has had the assurance to put in the quarter of a million dollars requisite to make another Homestake, though a whole procession of prospectors and coyoters have at different times jumped the best parts of the lode and struggled along with a one-mule arastra and pickings.

THERE is one gleam of comfort in the general demoralization of silver mining and its adjunct industries—and that is the increased attention paid to gold mining throughout the far west. While many thousands of discharged silver miners have gone east or become day laborers, others have drifted to the gold mining camps or have struck out into new territory in the search for the yellow metal. The prospecting season is nearly at a close in the mountains, but there is time yet for important strikes to be made.

UNFORTUNATELY for the new army of gold-seekers, most of the country has been pretty fairly prospected for gold long ago. Whether it be placers or gold quartz, the indications are comparatively simple, as against those of the complex silver ores; and for thirty or forty odd years, according to locality, other prospectors have been traversing the gulches, panning the creek sands, and looking sharply for gold quartz float. It is hard to find any region in this country nowadays that has not been overrun long ago by the gold hunters.

IT may not have occurred to most mining men that there is an immense difference between low-grade and lean ores. Mr. Richard A. Parker, who will have something to say about the Lake Superior iron ores in this magazine, calls especial attention to this distinction. When one is called upon to face a problem of handling auriferous iron pyrites, this difference in definitions begins to make itself practically felt. For example, suppose you have a three- to five-foot vein of iron pyrite, almost solid from wall to wall, but only running an ounce or a fraction of an ounce gold per ton, and situated in a place where the conditions are all against economical milling or chlorinating, and from which transportation cost is excessive. That is a low-grade ore. There is no use in concentrating it. Now, on the other hand, suppose that the three to five feet of vein matter consist of narrow streaks of high-grade ore, with intervening bands of barren gangue of some sort,—quartz, clay, talc, or what-not. Here is a proposition admitting of concentration on the spot and the shipping of high-grade concentrates to a distant smelter. The same rule holds with other classes of ore. It makes a big difference. Few miners realize it.

PROBABLY most mining men have at one time or another heard of "placer silver," and have very reasonably doubted the existence of such a thing. It is not believed that metallic silver in the form of fine grains, scales, or wire and dust can exist long when exposed, as it would be in shallow placer gravel, to the oxidizing atmospheric influences. It is true that some rather large masses of native silver have occasionally been encountered at and near the surface of the ground, but, so far as known, always tarnished and blackened on the outside and showing evidences of exterior oxidation, which in the course of time would mean a gradual solution and removal of the metal through the agency of saline solvents in the water. As a general thing, however, mines which carry native silver are not likely to show much of it in the croppings, but only in depth, where the vein is solid and protected from surface meteoric influences, as under the permanent water level. Yet there are those who believe in the occurrence of native silver in placers, in the state of fine grains and dust, corresponding to the common type of placer gold. The inventor and backers of a new amalgamating and concentrating machine are so enthusiastic over its merits that they claim to save by it large quantities of this placer silver, which they say is present in important quantities in the auriferous gravels and only escapes retention and notice because so fine and light that the rival machines and appliances cannot catch it. This machine is a combination of amalgamated plates with movable riffles; it has a trap at the lower end; is loosely swung by adjustable rods from a fixed frame, and is given a shaking "pan-motion" (somewhat like that of the common hand pan) by means of a rocking rod operated by a crank and gearing. The riffles are of sheet iron with rubber edges beneath, so as not to scratch the plates. It is intended as an adjunct to gold mills as well as for treating screened placer gravel. They claim that the amalgam taken from the plates often carries more silver than gold, and exhibit buttons of each metal obtained after retorting and parting,—which of course to the skeptical engineer is about as convincing evidence as the sight of the tons of rusty spikes exhibited in European cathedrals would be that they are all nails from the true cross. But while the new machine may work very closely, it has not yet demonstrated the existence of the suppositious placer silver. There are several ways in which it might be explained how large proportions of silver might be obtained in such an apparatus without resorting to the naturally suggested suspicion that there is any humbug about it. All native gold contains more or less silver, from the exceptionally pure 975 thousandths placer gold, down to cases running 700 thousandths and under. In such gold the 25 to 300 thousandths or more of alloy is practically almost all silver. Then there is the "white gold" of both placers and quartz veins, sometimes worth as low as $12 an ounce on account of the large proportion of silver in the alloy. Even the gold tellurides and native amalgams always carry some silver. At Bodie, California, this "white gold" has also been called "electrum" or "electron," in allusion to its pale amber color, though it is sometimes almost dead white. Such gold resists oxidation, and it is easy to imagine extreme cases that would give support to the placer silver theory, though as a matter of fact in the region where the tests were made it has not yet been recognized. Then a close-working machine might catch silver amalgam that had escaped from silver mills working above it, which amalgam is known to be often carried long distances in suspension in the streams, even to twenty and forty miles below the mills. In the present case there were no silver mills above some of the places tested. Or possibly the quicksilver used in amalgamating the copper plates might not have been retorted. Possibly there are other explanations. At any rate the case for placer silver cannot be said to be established until more systematic tests are made, with due precautions against error and salting. Assaying is out of the question with placer dirt in bulk, but careful panning of large sample lots of gravel and sand by the two-pan method (which is probably a more delicate test in skilful hands than any other), followed by a microscopical examination of the pan concentrates and assays of the latter, would soon settle the matter, at least in a negative sense as regards any particular locality. Meanwhile, pending such an examination, we are still in the dark as to whether "placer silver" exists or not.

It has been ruled by the court of appeals in Colorado that, where a person who has located a mining claim permits an adjoining occupant to patent that part of his claim on which is located his discovery shaft, the remaining portion thereof reverts to the condition of public lands, and is relocatable; and such rule applies, though the patentee made his location after such person.

Another recent mining decision of interest was rendered in a suit against an Idaho placer mining company. Under the statutes of Idaho, the party or parties owning a majority interest in a mining claim or mine, in the absence of any specific agreement to the contrary, have the right to the control and management of the same, subject to the laws of the United States and of the State. Where a mining corporation works a mining claim in which it has a minority interest, against the protest of the majority interest, and mingles with the gold extracted therefrom a portion of gold from its own claim, without the consent of the other party, and the quantity and value of such portion is unknown, it cannot recover the gold so mingled.

It has always been a difficult matter to dispose of small lots of unusually rich gold and silver ore at their full value, unless they happened to be of particularly showy appearance, and therefore could be sold at fancy prices as specimens to dealers in cabinet minerals. Latterly some establishments in the west, engaged also in sampling and testing ores, have been making a specialty of the trade in these small rich lots, for the convenience of sellers and mutual profit. The large smelting works as a rule decline taking ore in quantities of less than five tons, and the custom has been for the sampling works and ore brokers to accumulate these smaller consignments until they have a salable lot, then mix them, and turn the mixed lot over to the smelters. Now much of the extremely rich ore is being reduced on the small scale by special processes.

In looking over the "personals," a column of which is published in most of the mining journals, one cannot fail to be struck with the numbers of notices of American mining engineers now engaged in various distant mining regions of the world, notably in South America, Australia, and South Africa, either as superintendents or as examining experts and in consultation. It is something to be proud of that in so few years we have passed from the stage where this country had to rely upon foreign technical talent and skill, or upon foreign-educated Americans reimported, to a point where the services of American mining engineers and metallurgists are recognized and in demand elsewhere. It may be a national trait and reproach that we can't help everlastingly bragging; but here is something to brag about. It is observable, too, that our engineers generally are better paid abroad than at home.

An improvement in the endless traveling rubber belts used in the type of vanners of which there are now so many varieties consists in making the edge flanges of the belts incline at an acute angle toward the center. This form enables the belts to pass over the end rolls or drums without breaking or cracking. Another recent modification is the introduction, at intervals of about two feet, of a series of small transverse riffles (twenty, each the one-thirty-second of an inch in depth), extending over a space of about one inch across the belt. These riffles are intended to save floured sulphurets and amalgam that would not remain on a smooth belt, and to prevent channels being formed and the pulp from packing at the edges. The new rubber vanning belts thus combine the features of the standard smooth belts and the continuously corrugated belts.

Two measures have been pending before the senate in favor of the State mining schools of South Dakota and Colorado. The senate committee on public lands has agreed upon a favorable report upon Senator Pettinger's bill granting to the State of South Dakota 50 per cent. of the proceeds of the sale of mineral lands of the State for the maintenance of the State school of mines. In South Dakota they have some gold mines—and big ones too —which may possibly be benefited by the State mining school. But it is to be wondered what is to be the utility of the numerous mining schools of the country if half the mines are to be kept closed, and what chance of employment their graduates will have in the same contingency. Senator Teller, however, does not seem to have lost faith in the future of the mines, or the utility of the mining schools, for he has reintroduced the Golden school of mines bill, similar in provisions to the old bill, which proposes to aid the school with 25 per cent. of all the money recovered for mineral lands, limiting the same to $12,000 per annum.

The plain truth about mining schools in the United States is that there are too many of them,—too many inefficient ones. They all attempt to give a "high science" education which only two, or at most three,—it would be invidious to specify,—are prepared to furnish. It requires as big a capital to install a mining school with apparatus and teachers as a great smelter with furnaces and railway tracks. It also requires something else,—maturity and reputation, so as to attract a promising class of students and a faculty that have some reputation. The character of the students has much to do with success, owing to retroactive influence. The usual run of "professors" in the country technical schools are men who have been unable to do better work or secure higher pay. As a general thing, when a man is incompetent to do the thing he starts out to do, some board of managers picks him up and employs him to teach a lot of innocent, unsophisticated boys—how not to do that thing. So we have pedagogues and not engineers in charge of American mining schools.

If a boy wants a thorough technical training in mining and metallurgy, he had better take the usual academic course in one of the half dozen real universities (not in one of the three hundred pretences), and then go through the regular curriculum of one of the two or three mining schools that have the proper facilities and teachers. If he simply wants to learn the fire-assay and rough transit work, he can probably *be paid* while he learns; or at the worst go into some large assay office or surveyor's office and put in his time for nothing. You can teach a Chinaman the fire-assay in about a fortnight. The whole trick is in the use of the balance; the rest is plain cooking. Or, you can teach an intelligent ax-man or rod-man how to handle the transit or level in about the same time.

But if you want to train a boy in a deeper, broader way, so that the general principles of physics, mechanics, chemistry, geology, mineralogy, etc., can be grasped, why by all means give him a course in the most advanced schools—if you can afford it.

EVERY once in a while a reprint newspaper item is met floating about in the current of patent inside or patent outside or syndicate or block literature, concerning the treasures in gold and silver that exist in sea water. Exactly what the truth of the matter is we do not know, but, as the alkaline chlorides are solvent for both metals, in small quantity, the chances are that both are contained in the ocean, since the streams cutting through mineral veins all contain a little chlorine, iodine, and other solvents, no matter in how slight proportions,—and there has been plenty of time for concentration in the oceans. As to the analyses, they are mostly imaginary or doubtful. To detect a fraction of a grain per ton of gold or silver in the presence of the mass of alkaline salts is a delicate matter. Probably the use of amalgamated copper plates would be a better test than any concentration and analysis. The following extract however may be interesting:

All salt water contains a small per cent. of gold, says the Salt Lake *Herald*, and Capt. Davis, after numerous assays, satisfied himself that the water of the great lake carries $3 a ton in gold. After four years of experimenting, Mr. Davis has invented a method to extract the gold at a cost not to exceed 40 cents per ton. He estimates that there are 15,000,000,000 tons of water in the Great Salt Lake, and that it carries $45,000,000,000 in gold. To save this by using the method Mr. Davis has devised will cost 50 cents per ton, or $7,500,000,000, leaving a net profit of $37,500,000,000, the same being ten times more than the entire amount of gold money in the world.

ONE of the signs of the times is the remarkable depression in the iron blast-furnace output. The *American Manufacturer* (Pittsburgh) says that such a remarkable cessation of activity among the furnaces was never known. Even in the summer of 1891, when a concentrated shut-down action was undertaken by the furnaces in the Shenango and Mahoning valleys to bring the railroads to better terms on freight rates, and when the supply of coke from the Connellsville region was almost totally shut off by a strike among the workmen and furnaces were compelled to bank or blow out, even then the number of active stacks was much in excess of their standing on the 1st of August, 1893.

The same authority, to show how general the stoppage has been, appends a list of the districts in which iron furnaces have gone out; with the number of such stacks. It runs as follows: New York, 2; Pittsburgh, 3 iron and 2 spiegel stacks; Shenango valley, 2; Juniata and Conemaugh valleys, 3; Maryland, 3; North Carolina, 1; Mahoning valley, 3; Eastern, Central, and Northern Ohio, 5; Hocking valley, 1; Hanging Rock, 5; Alabama, 6; Indiana, 1; Illinois, 3; Missouri, 1; Colorado, 1. Virginia is the only State showing an increase of 1 bituminous stack in blast.

The iron and steel—consequently the coal, coke, and charcoal—trades are peculiarly sensitive in times of monetary stringency. Probably the best index of the financial condition of a country would be obtained by turning to these trades, and not to the banks, the insurance companies, and the investment and trust concerns. Preceding every panic the production of pig iron and its derivatives has always been large. But at the instant of doubt and insecurity it comes down like the mercury of a thermometer in a blizzard.

THE most complete list of returns of mining companies that we have been able to find shows for the first half of 1893 a total of $5,699,025 paid in dividends. This list is made up mainly of gold and silver mining companies, but it contains also some of the iron and copper mining companies of the Lake district. The reported earnings and dividends of the incorporated mining companies do not include the large number of single profits made by private companies and firms and individual owners. This good showing, in spite of hard times.

MACHINE SHOP PRACTICE

Conducted by Albert D. Pentz.

TELL a man just how by an unfamiliar process a thing is made, and he is interested at once. This is the secret of successful writing in all descriptions of technical operations; and the writer who is also able to make himself understood to men who are ignorant of the art described is sure of an audience. He may tell that which is commonplace to some of his readers, but let it be new to the general reader, written clearly and within his grasp of language, illustrated by a comparison of its processes with those familiar in ordinary experience, and more people will be interested than there would be if that writer should be able to demonstrate the quadrature of the circle.

ARTHUR'S furnace case hardened all right in its dilapidated condition, but he was not satisfied with it because it was in constant danger of falling to pieces. So it was rebuilt. Now it does not work well, although the heat is uniform and high. The work comes soft and irregular in hardness. Sometimes a piece will be hard on one side and soft on the other. Occasionally a piece will be cracked at one place and annealed at another in the endeavor to get good results. Arthur won't believe that the lime in the new mortar and perhaps in the brick can do this and will continue to do so until they are thoroughly burned out.

SULPHUR or sulphuric acid is, one of them opposed to the hardening of steel. In the processes of cold rolling and in the cold drawing of sheets and bars it is necessary to remove the scale, and this is ordinarily done in acids containing sulphur. This acid may be killed, but in most such cases there is a sufficiency left at the surface of the metal to prevent such surface from hardening as it should. Thus frequently it is noticed that a tool or part is soft at the surface but hard within. Screw rods coated in sulphate of copper have this defect more conspicuously than most other kinds of material.

IN turret machines, if the cutting edge or point of a tool be so placed that a slight difference in the position at which the turret is stopped in cutting position will affect the sizes of the work greatly, that placing of the tool is wrong. Such a tool should be set so that its edge holds a relation to the turret such that, if the turret be turned on its axis, the cutting point will cross the surface being cut on a tangential plane, and not come closer to the center of the stock than the size of the cut demands.

AS to oil channels: It is my belief founded on extensive practice that oil channels are neither the best nor the most practical means of distributing lubricants to distances from reservoirs and over extensive surfaces. Channels notoriously accumulate the dust which may come to them from every source, especially that which is abraded by friction from the surfaces being lubricated. This dust and viscous parts of the oil soon fill up these channels, especially in places where the oil is fed automatically to the bearings in minute quantities, and instead of a groove there soon becomes a channel filled by a pasty or hard mass of a very dangerous character, ready to cut the surface of the bearing whenever it may be washed out with benzine by the person noting the obstruction.

In place of channels every bearing or journal should be fitted as freely as is necessary to admit sufficient oil to keep the surfaces apart, and no freer. Between slow moving surfaces one thousandth of an inch is quite sufficient for this.

CASTINGS rusted red will paint better and not scale as much as those in other conditions of surface. On the contrary, the grey surface left after castings are pickled and dried frequently comes off and leaves a bare spot.

ALL pickled work should be very carefully treated before it is either japanned or nickeled; otherwise the coating will peel off. The best treatment is a hot soda or potash bath, then a clean hot water or steam bath, and then a thorough drying in a hot oven. Care must be had, if a water bath be used, to renew it quite often, as it soon becomes too alkaline and deposits when dry on the surface an objectionable film which prevents a close union of the plating or varnish.

THE greatest fault practiced by impractical buyers is that of initial cheapness. To such a person oil is oil and coal is coal, irrespective of the quality or the source of the product. The cause of their being impractical buyers is that old cause, "talk is cheap," and the fluent person often gets a position he is qualified by neither nature nor experience to fill. The effect of buying cheap is simply an abomination. Tools on screw machines refuse to do more than one half work with any except sperm or lard oils without destructive wear, and on milling machines the results are little better, and consequently what may be saved in price of the oil is lost many times over in wages and tools to do the work.

THE actual producer often becomes subject to the talker. In a certain factory, perhaps seven hundred miles from Chicago as the crow can fly, there are and have been plenty of first-rate mechanics, some of whom have good executive ability and all of whom are producers of good work in paying quantities. It has been the practice in that factory until recently to promote good workmen to be foremen and thence higher. Again, this practice has been a paying one, and that factory has been and is a most remarkable success in every sense. Recently, however, and covering a period of perhaps five years, there has been a disposition to subordinate the practical producers to accountants and other clerical people whose previous duties were to keep account of the work the mechanics performed. The most recent promotion in that factory is that of a clerk ignorant even of the names of the parts he is supposed to manufacture,—a person who does not know a monkey wrench from a vernier caliper. He however is a voluble talker, and the prosperity of that factory has so far removed the management from the workshops that accountants alone of all the hundreds of employés can get the ear of authority; hence the good talker gets the best of the good worker, and in time becomes his superior officer. It indeed must be a golden prosperity that can stand such treatment as that.

FEW factories run with less loss of power than thirty per cent., and this loss occurs whenever the engine is run, whether there is any work done or not. It is presumed that in the ideal future every tool and machine will be provided with its own electric motor; in the meantime, however, it is thought that a great deal of power may be saved by transmitting it to all shafts at a distance from the source of power on electric wires directly to a system of jackshafts each of which should be provided with a motor of its own. It is certain that this plan will save one half the lost power, if properly carried out. Most shops of considerable size can save the cost of dynamo and motors in one year.

IN an experiment get the result to work by the first mechanisms you find to answer the purpose. After the device works successfully, many other different movements and principles will be found by experienced manufacturing mechanics to remove crudities and get positive results with certainty.

WITHIN a barber shop on Myrtle avenue, Brooklyn, there are a number of gas burners suspended from the ceiling in the usual manner. Over each of the burners there is a porcelain arrangement to protect the ceiling from the heat of the gas flames. These protectors are suspended from the ceiling by chains and hang freely about two feet perhaps above the jets. Now every time the gas is lighted and the heat becomes considerable these pendent protectors commence voluntarily to oscillate quite vigorously, some of them more and some less. The length of each pendulum being about one yard, it is presumed that each oscillation consumes less than one second. The arc of oscillation in some extreme cases seems to reach about thirty degrees, showing that considerable force is developed by the flame. Now of course it is admitted that the heat of one of these jets may develop many times the force required to oscillate these reflectors, but how in this case did it do it.

IN designing machinery seek positive motions and avoid springs wherever possible.

DE GREE, during his recent vacation, bought a book entitled HOW TO RUN A FACTORY WITHOUT EXPERIENCE, and on his return he showed it to Mr. Blunt, telling that gentleman that he expected to gain considerable benefit from the information contained within its pages. Mr. Blunt, however, took no pains to conceal his contempt for the book, merely asking whether it had been written by some manager of great experience. Mr. De Gree admitted that the writer had not had any successful factory experience whatever. "There is no substitute for ability in factory management," said Mr. Blunt, "any more than in any other art requiring original work. You will remember that I object to specific factory rules, because of the obstinacy of men who never can be made to commit offences that exactly fit them. So I object to rules for management, because nothing comes up to be managed in such a way that the rules help much. It is a remarkable fact that old maids write the rules for managing children, and that most of the books for managing industrial concerns are the work of inexperienced men or of failures. If there be a man living who knows just what to do in every commercial emergency without specifically calculating that special emergency on its special merits, then that man is worth any sum that he may choose to ask for his services and get it too. Have you never wondered why the marvelous clairvoyants who advertise in the papers do not speculate in Wall street and get rich, instead of telling fortunes at fifty cents a head?"

A MAN'S ability is more surely gaged by marking how successfully he emerges from an emergency than by any other means whatever. There are many men who by taking thought and plenty of time can patiently do many wonderful works, but the man who can engineer a breakdown so that it is made to run till night and have it all repaired so that it can be started on time in the morning has the quality that wins battles and gains success in every sphere.

CONTRASTED to this kind of man is he who never is satisfied with the condition in which he is placed; who never gets the stock he requires or the tools needed for his work; who is always in the drag with his product, and who as continually seeks to fasten the responsibility for this on the acts or shortcomings of others.

THERE is no other way so good to emphasize a fact as to reiterate it. Thus there is no other means so good to cool a hot box as to pour on it alkaline or soapy water. The best way to make such a lubricant is to take about five pounds of tallow and perhaps two ounces of caustic potash. To this put about one quart of hot water, and then with a jet of hot steam reduce the soapy mass to the consistency required. This lubricant is certainly the most satisfactory one I have ever used where hard duty is required.

SUPERINTENDENCE is not only the getting of results personally, but the faculty of organizing the whole force so that every man in a responsible position is interested in the getting of results also. The doing of this requires no special ability, but it necessitates that the superintendent shall be a man who can recognize and appreciate valuable service, and reward it in such a manner that the recipient of the reward sees in it an encouragement to still further exert his force and to urge the work in his charge forward to a more economical result.

ORDINARY boiled linseed oil is the best varnish known for cast iron surfaces. Of course the metal will not absorb the fluid as wood does; so the whole of the gums contained in the oil remain on the surface, where it is hardened by evaporation. It may also be a fact that there is some union between the metal or some of its impurities and the oil, for certainly it dries very soon and very hard. Few persons know how rich a surface a casting can have until they have experimented with it. A casting with a good surface pickled and washed with warm water or steam will be a rich brown. One pickled and not washed will be a peculiar grey, and one pickled and washed with cold water will be a brilliant red. Care must be had to not file or chip such castings more than necessary, and to never attempt to improve the surfaces left by the sand, as that surface cannot be improved in artistic appearance by filing.

DRILL jigs are pretty good as indicators of the experience of a mechanic in designing tools for efficiency. If a jig be made like a dark pocket into an end of which the part to be drilled is shoved, then there can be no good results got from it, for it can be neither cleaned nor kept clean, nor can it be known whether it be clean or not. Next to equalizing the work, to keep it from being sprung in fastening, the keeping of it and its supports with no dirt between them is of the greatest importance. To know there is no dirt on the seats in a jig is quite as necessary as to know that the drill is of the correct size, for in machine building nothing can be taken on faith. Therefore, when the jig is empty, every part of its seat must be so placed as to be seen, and the parts that obstruct the observation of them and the cleaning of them must be removed whenever possible. Very frail and springy parts must have the most rigid jigs, while other stiff and solid pieces may well support the jigs that locate the holes to be drilled in them.

DRAWINGS are good, but models are better. If only one of these elements can be had, let it be models of the parts to be manufactured.

LARGE bright surfaces are not so effective in appearance as large painted surfaces relieved by narrow or small bright edges or spots.

DOWEL pins cannot satisfactorily be drilled in the jigs within both of the parts they are intended to locate in exact position the one on the other. The most satisfactory way is to drill the outside part in the jig and to transfer that to the other when they are assembled. This refers more particularly to large or medium machinery, and where exact results must be obtained. In watches, however, and very delicate instruments, where enormous quantities are made of very small parts having short dowel holes, these may satisfactorily be drilled in perfected tools before they are assembled.

IT is possible that there is a mechanical power in elasticity, and that this power is neither of the lever principle nor of the wedge principle. Thus, if a number of pieces of soft india rubber be placed the one on the top of the other, and if when in that position it requires eight pounds placed on the top of all to depress the pile one inch, then, if the pieces are all alike in every respect and if they be taken down and placed on a plane surface with weights on them covering and depressing all alike, it will take sixty-four pounds to depress them, as a whole, one-eighth of one inch, which is exactly the amount, one-eighth of an inch each, that eight pounds depressed them in the first position when they were in one pile eight layers high. Thus it will be seen that the ratios of power required to depress each of these springs a given distance is exactly proportional to the distance which the weight has fallen, as in the case of a lever or a wedge. A coiled spring regularly wound and cut into sections of equal length shows this same peculiarity, as also will a series of flat springs. I am not now able to apply the advantage thus gained to useful purposes of mechanical value, but that may be because this phase of the subject has but recently interested me. It is certain, however, that the elastic principle contains a mechanical power, and that it to my knowledge has not been noticed before.

One fact, however, is demonstrated by this spring problem, and that is that the stiffness of a coiled spring is inversely proportional to the length of wire it is made of, all else being equal. In fact, many things may be unequal, and the stiffness of springs will remain thus proportional to the length of the wire they are made of.

The subject of files becomes again and again one of paramount importance, for it is a fact that there are no files made in this country that are at all comparable to those made by Stubbs in England. This is a disgraceful fact, for in no other art are we so far in the rear of European countries as in file-making. It is not alone quality of the steel,—and that is bad enough, some of it being bought for about four cents per pound,—but the cut is weak, being unsupported behind the edges or points of the teeth. I believe files could be milled better than they can be cut by any other process, and thus the best shape of teeth may be made with certainty, economy, and ease.

The proprietor of one of the most successful of enterprises located near New York city in a recent conversation stated his conversion to the belief that "a strict military discipline is best by which to govern a factory." He further states in substance that in his works he had found that there could be no real efficiency if he gave orders except through his manufacturing superintendent. He found that, when he, innocently enough, instructed his men directly, they presumed on the fact and became disrespectful to their immediate superiors. The men also made a practice of boasting of the notice they received from the proprietor and of the fact that they got their instruction from him, showing that they had a contempt for those directly above them. Another effect of this was that superintendents became discouraged and did not take the interest which they should and which they now do since the change in the proprietor's practice is to give orders to them directly.

My friend Thomson manufactures a small specialty, but his principal work is jobbing. One of his customers, who supplied him with a reasonable amount of business, began about a year ago to agitate for a better price, so that he could meet the competition more successfully.

Thomson in the pride of prosperity refused to do this, yet the customer continued to patronize him, under protest however. Now after the panic has come the customer has no difficulty in getting his work done at another shop as cheaply as he desires. Thomson is profanely and abusively indignant at being forsaken by "that man whom I stood by for years and years. Now he leaves me just to get his work a few cents cheaper. He gave me no warning, but just took his work away and gave it to that red-headed scalawag from Hartford. Bah!"

CURRENT TECHNICAL LITERATURE

THE LAW OF INCORPORATED COMPANIES, OPERATING Under Municipal Franchises. By Allen Ripley Foote and Charles E. Everett, with a resident attorney in each State as co-editor. Cincinnati: Robert Clarke & Co. 1892. [Three Vols. Law Sheets. $15.]

THIS is a valuable work, which has been produced only by great labor and at large expense. It consists of three handsome volumes, of nearly 3000 pages, and represents the work of forty-eight contributors extending over a period of three years. The subject thus carefully treated does not include the whole range of corporation law, but is confined to the law of corporations, operating under municipal franchises. In other words, the branch of law covered is that which applies to corporations formed to carry on business under some municipal grant, as, for instance, a gas, electric-light, telephone, street-railway, or water company. The aim of the authors in treating this subject has been three-fold: (1) to determine from an economic standpoint whether these public enterprises shall be carried on by corporations, and, if so, how these bodies shall be controlled; (2) to outline the distinctive features of the general law now applicable to such corporations; and (3) to present the existing law, whether constitutional, statutory, or judicial, in each one of the States upon this subject, so that a comparison of methods and laws may be readily made for the common good. These separate aims have caused a division of the book into three parts.

The discussion of the economic principles that control the subject is conducted by Mr. Foote. It is an earnest and interesting plea for a change from the existing methods of granting municipal franchises and in behalf of the adoption of an entirely new plan. The plan proposed contemplates the establishment of a department of government to be known as the Department of Municipal Administration. This department, according to the author, should have supreme control of all municipal highways and of all corporations desiring the right to use them for any purpose. The charters of the companies should be issued upon certain specified conditions, and the State and the corporations are to go into practical partnership in the conduct of the business in reliance upon these conditions. The new department, it is claimed, should have the powers of a court, and all questions between the corporations and their users should be disposed of by it; it should also be authorized to require the most searching reports, and should have access to the books of the corporations at all times. Provision is made for a division of profits between the State and the corporations, and the many benefits that would probably result from this new order of things are pointed out. But the objections to the scheme are not given equal prominence. Aside from the fact that many will strenuously object to it because it is a plan for absorbing the attention of government with work that private enterprise will manage much more effectively and which is beyond the scope of the government unless demanded by public necessity, it is quite evident that municipalities will not readily surrender to the State the right to grant these franchise rights. Moreover, the street-railway, telephone, gas, and other similar corporate bodies surely will not be eager to put their interests in the hands of a partner, who is a sharer in profits, a judge of all questions that may arise in the future, and a legislator with power to make laws to suit his own convenience. With such a partner the rights of the corporation would be indeed slender. In our judgment investors would not put their funds into undertakings where the returns upon their investment were to be decided upon by the emissaries of the State who were occupying the chairs in the Department of Municipal Administration. And corporators would not for a minute tolerate such inroads upon their private rights as would be necessary to carry out a scheme of this character. To us the whole plan of the creation of such a department of government seems impracticable and unnecessary, and, although no doubt evils may be detected in the systems of granting public franchises now in vogue, these evils should be remedied without this wholesale destruction.

The second portion of the work contains a general view of the law governing the subject. This is well written and shows careful investigation. Many authorities to sustain the propositions of the text are also cited in the foot notes. The following chapter headings illustrate the scope of this discussion: (1) Introductory; (2) historical; (3) constitutional limitations; (4) powers of State legislatures; (5) public use—public policy—vested rights; (6) franchises; (7) streets and highways; (8) monopolies—conflicting grants; (9) municipal corporations; (10) franchise companies—individual rights; (11) conclusions.

By far the largest portion of the work is given up to the third part, which contains exhaustive statements of the law governing these corporations in the different States. These contributions from the pens of lawyers throughout the country contain much that is of historical value in relation to these corporations, and the compilations appear to be made with much care. The presentation of the laws of Massachusetts is particularly noticeable for its careful research. It may be noticed that with the rapidly changing legislation of recent years it is impossible to give all the latest laws in a work of the character of that now before us, and one must examine the session laws of 1892 and 1893 before he can feel sure that he has all the new acts before him. This is a matter of much importance in the State of New York, for in the chapter devoted to the laws of that State numerous provisions are quoted from the General Corporation Law and the Stock Corporation Law of 1890 which are no longer in force.

The work is excellently printed and bound, and as a whole it is calculated to serve most useful purposes in quickening thought in relation to the problems surrounding the control and management of these corporations, in bringing within the reach of all investigators this large body of legislation for comparative study, and in giving the busy lawyer the statutes and decisions of the different States upon this subject in compact shape.

DWIGHT A. JONES.

THE RAILROAD QUESTION. BY WILLIAM LARRABEE, late Governor of Iowa. Chicago: The Schulte Publishing Co. 1893.

MR. LARRABEE, while Chief Executive of Iowa, was known as the anti-railroad governor; he seems to have kept up the character, for the present book is not so much an argument as a screed against railways. It will not be contended that our transportation history has not developed commercial wrongs, but it is certainly a misstatement of that history to put forth such a book as a discussion of "the railroad question." Mr. Larrabee seems to have read all the literature published in English adverse to railroads, and to have taken from them a long list of alleged grievances. If he mentions anything favorable, it is but to argue at length against it. The German and French literatures on the subject are scarcely referred to. The reader does not need to be told that such a method of discussing this or any other political or economical problem has no value whatever and must defeat its own purpose. It would be a waste of time to take up seriatim the charges brought against railroads of monopolizing, combining, subsidizing the press, corrupting politics, watering bonds and stocks, ruining farmers, and the like. Admitting that there is an atom of truth at the bottom of some of these alleged grievances, we need a calm consideration of the whole question if we are to find a remedy, supposing that to be our object. Shakspere's phrase "there is some soul of goodness in things evil" is as applicable to transportation as to morals. Salvation does not consist in obliterating morality, but in perfecting it.

So in commerce: the wise leader will with the bad consider also the good, that he may make perfect, not destroy. Some shippers are injured by unjust discrimination, we will say, yet on this account to repress the agencies without which the farms in Iowa would be worthless would be a commercial sin; to hamper them in their work of benefiting the nation at large would be fatal. To remedy the first-named injury by restricting the usefulness of the whole system of railways would be absurd. Our railway problem is admittedly a hard one in many respects, but no help is gained in writing or in reading such a book as the one under review. It does not require detailed refutation of the many false positions taken; indeed it does not need notice at all except that the readers of this Magazine may know beforehand its worthlessness, and that even the citizens of the ex-governor's own State may not be misled into supposing that the writer of the book has really discussed "the railroad question."

T. L. GREENE.

SEWAGE PURIFICATION IN AMERICA: A DESCRIPTION OF the Municipal Sewage Purification Plants in the United States and Canada. By M. N. Baker, Associate Editor *Engineering News*. With 79 Illustrations and an Index. New York: Engineering News Publishing Co. [Paper. 8vo, 196 p., $1.]

FORMERLY, owing to a lack of examples at home, when an American engineer wished to construct a sewage-purification plant, he was obliged to study foreign practice, either by going abroad or by consulting books. But within ten years past a number of sewage-purification plants have been built in this country, some of them unequaled by any abroad except in magnitude. In addition, the Massachusetts State Board of Health has contributed largely to the world's knowledge of the subject by its experiments at Lawrence, so that there now exists plenty of information on this subject near at hand. But until quite recently many of the American examples had not been described at all, while such descriptions as did exist were scattered through engineers' reports and engineering journals. This fact led the *Engineering News* to begin the publication of a series of articles based upon personal visits to various sewage-purification plants, with drawings and descriptions furnished by the designing or constructing engineers, or the officials in charge. These articles have been revised and reprinted in book-form.

This volume describes six intermittent filtration plants, eight plants employing chemical treatment, and fourteen that have tried broad irrigation, together with five others using different methods. The broad-irrigation class includes ten western localities, under the title, "The Use of Sewage for Irrigation in the West." These cities are in or near irrigation centers, and the sewage is used quite as much for the sake of moisture to the crops as for its fertilizing properties, although purification is generally the main object.

Perhaps the best-known works described are those located at Pullman, Ill., and South Framingham, Mass., where both irrigation and intermittent filtration have been practised, and at Worcester, Mass., and East Orange, N. J., where chemical precipitation is employed. At East Orange precipitation is supplemented by the application of the clarified sewage to grass land and to beds of gravel and cake. All the other chemical-precipitation plants rely wholly upon this one process, and South Framingham and Pullman are the only plants that combine irrigation with filtration. With scarcely an exception the author found the works he visited remarkably free from the objectionable features popularly ascribed to sewage-purification plants.

In general we may gather from this volume that intermittent filtration has proved highly successful in this country wherever it has been fairly tried, and that chemical precipitation has given very fair satisfaction, except where the process has been crippled by too great economy in the use of chemicals. The chemicals most used are lime, alum or sulphate of alumina, and peroxide of iron. Crops are seldom raised on intermittent filtration areas, and thus far sewage-farming, although broad irrigation is quite common, has not been carried on in a very scientific manner, western farmers using the sewage much as they would water, merely to give moisture to their crops. The use of the sludge from chemical-precipitation works as a fertilizer seems to be growing in favor, but thus far the most that can be expected is that farmers will draw it away, if given to them. The severe winter climates of the north do not interfere with land disposal so much as would be expected. Altogether, the outlook for sewage-purification in this country is encouraging, and with the advance of popular sanitary knowledge the demand for a cessation of the contamination of water-supplies is rapidly increasing.

VENTILATION AND HEATING. By JOHN S. BILLINGS, A. M., M. D., LL. D., D. C. L., Member of the National Academy of Sciences, Surgeon United States Army, etc. New York: The Engineering Record, 1893. [Cloth. 8vo, 495 p., $6.]

THE art of ventilation is so intimately related to that of heating buildings that neither can be scientifically and adequately discussed by itself. In recent times good ventilation in all buildings is coming to be more and more regarded as an absolute essential to maintaining the highest standard of physical and mental vigor. It is true that people may live and study and work in comparatively ill-ventilated buildings for long periods without suddenly wrecking physical or mental health; but in the increasing struggle for subsistence and precedence in modern society the question each man or woman who has entered for the race has to answer is not merely how he or she can do *some* work, but how each can do the *best* work and attain to the *highest* plane of physical and mental vigor, so that the *most* of work, or of pleasure (work *and* pleasure, if the reader please), can be realized in the brief span of human effort. As truly as a nourishing digestible diet is needed to maintain healthful life, a plentiful supply of pure air for breathing and for displacement of exhaled impurities is needed in order that the human organism may work up to the full measure of its power.

A book that so plainly sets forth the true principles of ventilation that all intelligent, educated people who will take the trouble to read it may understand these principles; that not only points out the evils of deficient ventilation, but verifies them; that not only clearly states the requirements in apparatus for good ventilation, but also the difficulties to be met in securing such requirements, at the same time being so free from technicalities as to fit it for the use of lay readers without lessening its value for men technically trained,—is a welcome addition to the hitherto somewhat meager books upon ventilation. Such a book has been supplied by Dr. Billings, who has made ventilation a special study for many years. This author, while bringing to his work a rare scientific and educational equipment, possesses the happy faculty of writing in a popular style without thereby being betrayed into weakness and error in the enunciation of principles,—a faculty not frequently met in writers upon scientific subjects.

The ready understanding of the text in this book is assisted by 210 illustrations, including diagrams serving to make plain the construction and uses of various instruments and apparatus essential to the determination of direction and velocity of air-currents in inclosed spaces and flues, and the chemical analysis of air for ascertaining qualitatively and quantitatively the impurities in it. Copious and detailed illustrations of ventilating apparatus employed in important examples of practice in heating and ventilating private and public buildings are also given. The part of the work devoted to such description and illustration will prove of more value to architects and engineers than to lay readers. Some space is also devoted to ventilation of mines, ships, stables, barracks, etc. Under these headings may be found considerable matter, which, however, adding a little to what is now made part of regular instruction in schools of mining, will be of interest to those engaged in ventilating buildings by way of general information, rather than from new facts contributed to the common stock.

While as a whole this book is worthy of very high commendation, in both purpose and execution it does not speak with such positiveness and authority upon some scientific and practical points relating to ventilation and heating that all its statements will be accepted without demur by heating and ventilating engineers and architects. For instance, the yet unsettled state of the questions whether upward or downward ventilation is to be always preferred, or whether, according to circumstances, either may be sometimes better than the other, or whether a combination of both may not, under certain conditions, be more advisable than either used singly, may be cited. In the discussion of this subject Dr. Billings rehearses the arguments in favor both of upward and downward ventilation, but adds little if anything of value to the discussion that was not already familiar to experts in heating and ventilation prior to the appearance of his present work. In fact, the reader, after perusing what is said of "inlets and outlets" in the eleventh chapter, and the general discussion on direction of flow in ventilation in the fifteenth, will probably get the impression that the author has not himself arrived at positive and definite conclusions upon this subject.

On page 132 the author criticises a habit of some engineers, in specifying ventilation, wherein they are wont to base calculations upon the number of times the air volume in a room to be ventilated is to be changed per hour, meaning by this the number of such volumes of pure air that shall be forced into and through the rooms. Now the basis of such a specification is rarely anything else than the number of cubic feet of fresh air, proposed to be supplied for the maximum number of people which it is assumed will occupy the room. When this is determined, there is no apparent objection to reducing it to terms of the volume of the space to be ventilated.

In some of the propositions made with more or less positiveness by the author, there appears to have been some want of due consideration. For example, on page 84, is found the sentence:

"*Pure air contains no stored force*, and cannot properly be called a food." The proposition contained in the italicized words will seem strange to a student of thermodynamics; and, unless they were intended to mean exactly what they say, it puzzles the mind to conceive either what idea is intended to be conveyed by this curious statement or the sequence of the unitalicized words to the first part of the sentence. The proposition that air contains no stored force is so inexact that it could scarcely have been written by a man of Dr. Billings's attainments except through an inadvertence. How are the tension of air, the work it performs while expanding, and its resistance to compression to be accounted for except by the fact that it has, at any temperature and pressure, a stored expansive force?

An attempt to find what is said on various topics treated in the volume through the aid of the index shows the latter to be far too incomplete for a work like this, which in the hands of professional men should become a valuable work of reference. For instance, while diffusion of impurities, as gaseous bodies, in air, is frequently mentioned in the book, one looks in vain for the word "diffusion" in the index. Dust is also frequently spoken of as important to be considered in relation to modes of ventilation, filtering air, etc., but in finding what is said about it the index affords no help. The defects of which these are a type are regretfully mentioned as samples of a kind of perfunctory work too frequently met with in indexes, particularly in American books.

LEICESTER ALLEN.

THE BIOGRAPHICAL DIRECTORY OF THE RAILWAY OFFICIALS of America. Edition of 1893. Edited and compiled by T. A. Busbey. Published biennially by The Railway Age and Northwestern Railroader. Chicago. [8vo, 418 p., $5.]

THIS is a very convenient and useful volume. Instances are constantly arising when information is needed in regard to the careers of prominent railroad men, as well as of men who have lately come into prominence in the railway world, and we all know how little is to be learned on the subject from the ordinary sources of information. A reference to this Directory answers every question that is likely to arise in the business office.

HENDRICKS' ARCHITECTS' AND BUILDERS' GUIDE AND Contractors' Directory of America. For the years 1893-94. Published annually by Samuel E. Hendricks Company, New York. [8vo, 650 p., $5.]

THIS Directory is the only complete work of its kind in existence. It is a complete directory of all the construction industries of the country, containing over 170,000 names, addresses, and business classifications, comprising builders and contractors of material and construction in the building and kindred industries. The list of American architects is complete and accurate, and no less accurate are the lists of architects in Canada, Cuba, and Mexico. There are also full lists of the manufacturers of, and dealers in, everything employed in the manufacture of material and apparatus used in the building industries, from the raw material to the manufactured article. There are over 800 separate classifications, and the system adopted is excellent.

ELECTRIC LIGHTING AND POWER DISTRIBUTION. An Elementary Manual for Students, etc. By W. Perren Maycock, M. I. E. E. Parts I, II, and III. Illustrated. New York: Macmillan & Co.

THE author of this work is a well-known teacher in the City and Guilds of London Institute, perhaps the most successful technical institution in England. Finding from experience that there was no satisfactory elementary text-book suitable for the instruction of beginners, Mr. Maycock has undertaken to supply the deficiency by the preparation of this treatise. The present edition is in three parts, and is in paper covers, but in a new edition the parts will be bound together in permanent form. A somewhat careful examination of Mr. Maycock's work justifies us in speaking of it in terms of almost unqualified commendation. Everything is made plain to the comprehension of the student; mathematical formulæ are introduced as sparingly as possible, but concrete numerical examples are used throughout in great abundance. The author mentions a very pretty "American" method of getting at either of the three fundamental equations of Ohm's law, which deserves to be better known than it is, viz.: "Write down the formula $\frac{E}{CR}$; place your finger over the quantity required, and it is equal to what remains." The whole subject of industrial electricity, with the exception of the electric railway, receives thorough consideration. Of course, the illustrative examples given are mainly of English and not of American practice, but the principles are alike in both, and this is the important thing.

ELECTRICITY UP TO DATE FOR LIGHT, POWER and Traction. By John B. Verity, M. Inst. E. E. New York: Frederick Warne & Co. [Cloth. 12mo., 163 p., 75 cents.]

THE fact that this little work has reached its third edition is an assurance that it is not wholly destitute of merit. Its contents are mainly of a popular character, but the explanations of electrical apparatus and processes are concise and clear, and call for little or no criticism from a technical point of view. We should be glad to feel assured of the final retirement of the venerable French engraving of the electric arc after its reappearance for the five-hundredth time, more or less, in this work, and the substitution of something more nearly representing modern conditions, but that is perhaps too much to hope for. The American electrician will find one thing of value in its pages not so conveniently presented elsewhere, so far as we know, and that is a statistical account of each of the electrical-supply companies now operating in London, with a colored map showing the geographical districts respectively allotted to each. A very good glossary of electrical terms is appended, together with a satisfactory index.

NEW BOOKS OF THE MONTH.

Allen, W. W. and Avery, R. B.=California Gold Book. First Nugget: its discovery and discoverer; account of the discovery of gold in 1848-49. Chicago: Donohue, Henneberry & Co. [49 pp.]

Brierley, A.=How to Become an Expert Book-keeper: a New System on the most Simple Principles for Self-Tuition. New York: Excelsior Publishing House. [32mo, 220 p., cl., 50 cts.; indexed, 75 cts.]

Calderón, Climaco, and Britton, Edward E.= Colombia. New York: Robert Sneider. [8vo, 122 p., paper, $1.]

Foote, Allen Ripley.=Prosperity and Politics. Washington: Kensington Publishing Co. [16mo, 187 p., paper, 50 cts.

Gresley, W. S.=Different Methods of Working Coal in Various Countries. Erie, Pa. [32mo, paper, 61 p.]

Haferkorn, H. E.=Handy Lists of Technical Literature. Reference catalogue of books printed in English from 1880 to 1888 inclusive; to which is added a select list of books printed before 1880 and still kept on publishers' and jobbers' lists. Parts 5 and 6, Fine Arts and architecture, painting, sculpture, decoration, ornament, carpentry, building and art industries, etc., include issues up to May, 1893, and a number of earlier books frequently met with in catalogues, with a list of periodicals and annuals in these branches. Milwaukee: H. E. Haferkorn. [4to, cloth, 664 p., $3.50.]

Hall, T. B.=The Infringement of Patents for Inventions, not Designs—with Late Reference to the Opinions of the Supreme Court of the United States. Cincinnati: Robert Clarke & Co. [275 p., 8vo, $5.]

Houston, Edwin J.=The Electric Transmission of Intelligence, and Other Advanced Primers of Electricity. New York: W. J. Johnston Co., Ltd. [8vo, 330 p., cloth, $1.]

Howells, W. D., Clemens, S. L., Shaler, N. S., and others.=The Niagara Book: A Complete Souvenir of Niagara Falls. Buffalo, N.Y.: Underhill & Nichols. [12mo, cloth, 230 p., $1.25; paper, 50 cts.]

Local Engineering Data for St. Louis. St. Louis: The Engineers' Club. [52 p., paper, 75 cts.]

Molesworth, Guilford L. and Robert B.= Pocket Book of Engineering Formulæ and Memoranda. New York: Spon and Chamberlain. [Leather, 815 p., $2.]

Munro, J.=The Romance of Electricity. New York: Fleming H. Revell Co. [8vo, cloth, 320 p., $2.]

Perkins, George A., and others.=Report of the Commission to Improve the Highways of the Commonwealth of Massachusetts. Boston: Wright and Potter. [8vo, cloth, 238 p., $1.]

Pomeroy, J. Norton.=A Treatise on the Law of Water-Rights, as the Same is Formulated and Applied in the Pacific States, Including the Doctrine of Appropriation and the Statutes and Decisions Relating to Irrigation. A revised and enlarged edition of "Pomeroy on Riparian Rights" with several additional chapters by H. Campbell Black. St. Paul: West Publishing Co. [8vo, 628 p., sheep, $5.25.]

Principles of Fitting for Apprentices and Students in Technical Schools. By a Foreman Pattern-maker. New York: Macmillan. [12mo, cloth, 323 p., $1.50.]

Rothwell, R. P.=Universal Bimetallism and International Monetary Clearing House. With a record of the world's money, statistics of gold and silver, etc. New York: Scientific Publishing Co. [8vo, cloth, 75 cts.]

Todd, Mrs. Marion.=Railways of Europe and America, or Government Ownership. With notes from official sources. Boston: Arena Publishing Co. [12mo, 288 p., cloth, $1.25.]

White, Gleeson.=Hand-book on the Preparation of Working Drawings. New York: Macmillan. [12mo, cloth, 327 p., $2.50.]

Wilson, Edward L.=Photographic Mosaics: An Annual Record of Photographic Progress, New York: Edward L. Wilson. [8vo, paper. 332 p.]

NEW TRADE CATALOGUES.

Any of these catalogues free on application to the manufacturers.

The Edward P. Allis Company, Milwaukee, Wis.=The Reliance Works and Some of Its Products. 50 p. [Views of important flour-mill, saw-mill, and engine-plants, equipped by this company, including some of the most important in the United States.]

The Hanson and Van Winkle Company, Newark, N. J.=Process of Electroplating by Bicycle-Power Plating Dynamo. 16 p. [A novel machine affording a reliable source of electrical energy suitable for deposition of metals on a smaller scale than has been convenient with the apparatus at hand.]

The Graves Elevator Company, Rochester, N. Y.=Elevators. 100 p. [Describing and illustrating every kind of elevator and many new devices for speed, safety, and economy.]

C. S. Knowles, Boston, Mass.=Material and Specialties for Electrical Purposes. 24 p. ["Tenax" rubber friction tape, "onyx" tape, "tenax" line tape, gas-fitter cement, hard rubber battery cells, rubber car springs, etc.]

Riehle Brothers Testing Machine Company. Philadelphia, Pa.=Illustrated Catalogue No. 3, 2 vols. 150 p. [Descriptions of testing machines, marble molding and countersinking machines, ball-bearing screw jacks, pig metal trucks, etc.]

Pittsburgh Locomotive Works, Pittsburgh, Pa.=Locomotives Exhibited at the World's Columbian Exposition. 50 p. [Eight wheeled passenger compound, ten wheeled passenger, mogul compound freight, ten wheeled freight, four wheeled saddle tank, etc.]

The Northwestern Terra-Cotta Company, Chicago, Ill.=Illustrated catalogue. 46 p. [Photographs of buildings recently erected partly or entirely of Terra-Cotta, and figured scale drawings of designs for which molds are kept in stock.]

Westinghouse Electric & Manufacturing Company, Pittsburgh, Pa.=Transmission of Power. 79 p. [Description of systems and apparatus furnished by the company. Direct-current systems, the two-wire synchronous system, Tesla polyphase system, overhead lines, etc.]

Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.=Illustrations of standard apparatus 58 p. [Direct current generator, current diverter, stage regulator, compensator, ground detector, etc.]

Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa.=Electric Railway apparatus. 60 p. [Motors, car-equipment, generators.]

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CANADA AND OUR NEW TARIFF.

By Erastus Wiman.

CANADA may always be relied upon to furnish to the United States a series of unsettled problems of prime importance. It is natural that this should be so, inasmuch as the Dominion is a large country, and the nearest to the union of commonwealths that adorn the lesser half of the continent. While two powers possess the continent in common, and the two systems of government are animated by a spirit of reprisal in commercial policy, just so long will there be friction, irritation, and possible belligerency.

The varied nature of the interests affected by this condition, along a border line unparalleled in length, is not greater than the gravity and the far-reaching consequences of the questions constantly at issue. From the war of 1812, so fruitless and expensive, down through all the disputes as to boundaries, even until now when it is unsettled as to which nation possesses the rich mineral regions on the distant Yukon River, there has always been a question as to territorial areas in which the whole country has had an interest. The interpretation of Shore Line treaties, antiquated and inapplicable to the present advanced condition of civilization, has resulted in large payments from the general treasury for fishing privileges, the subsequent surrender of which was followed by the presence of armed cruisers in the Gulf of St. Lawrence, menacing a peaceful pursuit, and by the exaction of a tonnage tax on American fishing craft, even now submitted to temporarily as the price of peace. A constant refusal to permit the shipment of a few quintals of fish by rail in bond meantime is regarded as entirely justifiable by the Canadian government, even in the face of permission by the United States to transport in bond produce and merchandise to and through Canada in proportions so enormous that, should the privilege be abrogated, it would bankrupt the entire Canadian railway system. Equally, the most serious menace which could possibly be maintained against the vast transportation interests in the Northern States and in the trans-continental lines is found in the unbridled competition of Canadian railways, constructed largely on subsidy, and maintained by the constant contribution of English money, and which are without the pale of rigid Inter-State regulation, to which American lines are subjected. So, too, at this late day, a great diplomatic court is convened in a European capital to settle a Canadian question, affecting the Behring Sea, in which the United States and Canada are alone concerned, resulting in a wide discussion of international law by an aggregation of forensic ability rarely gotten together in the history of litigation. So wide is the range of subjects of difference between the two countries, so continuous the dispute, so far-reaching the consequences, that it would seem as if no effort of government of this great country was so important as that which guided its policy towards Canada. Yet it is a fact that on no subject is there among the people at large greater ignorance, and among politicians greater danger of misapprehension.

Aside from the gravity of the questions which unsettle the repose of the two nations, there is always present the shadow of a European complication which inheres in almost every point in relation to Canada. An integral part of the great British Empire, forming as the Dominion does indeed a proportion no less than forty per cent. of the vast area included in the Britisher's boast of a nation upon which the sun never sets, there is always a consciousness of complication in relation to Canadian matters not possessed by other problems. Great Britain is the best customer of the United States, the largest creditor, the warmest friend and most helpful co-partner in the advancement of the highest form of civilization. Anything that would disturb the peaceful relations between these two nations, bound together by ties so intimate and so essential to the existence of each other's prosperity, is to be considered as paramount in importance over everything else. Yet almost every time a Canadian question is evolved it carries with it the possibility of a disturbance between the two English-speaking nations that dominate the world. This danger is all the greater because of the jealous care with which the possessions of the British Crown are guarded, and more especially by the constant feeling among the thinking people of Great Britain that in no part of the empire is the conflict so prevalent as in Canada between the sentiment of loyalty to British connection, on the one hand, and, on the other, the personal interest of a majority of the population promoted by the closest possible connection between the Canadian and the American peoples. In no part of the empire is the temptation toward secession so great ; in no part would secession be so complete and so fatal to the prestige of the empire as in the case of Canada. Measured by the effort which Great Britain put forth in the War of Independence to retain the American colonies, the secession of Canada would be the most stupendous event at present possible to the Mother of Nations. The possibility that republican institutions should suddenly pervade so vast a proportion as forty per cent. of the empire over which the monarchy rules would do more to sap the foundations of that monarchy itself than any other possible event. Such a contingency, following the yielding tendency towards Democracy apparent in recent legislation in Great Britain, would be regarded by many as the first step towards reducing England to the position of a second-rate power, lessening her military and naval force and eventually resulting in a serious set-back to civilization.

It is true these are far-off considerations ; yet they are all influential in the relation of Great Britain to her greatest and nearest colony, and incidentally affect the relations of the United States with her greatest and nearest neighbor. So long as the English government, as a first-class military power, controls the destiny of the greater half of the continent, just so long will the Canadian problem possess undue and unusual significance to the United States, rendering it difficult to solve, and perennial in its reproduction in various and novel forms.

There is one question, however, of relationship between the two countries that consideration of England does not affect. That question is the tariff between the two portions of this continent. This subject is one of legislation with the United States and Canada, and is not necessarily affected by diplomacy in which England need take part. Now that it is contemplated by the recent mandate of the American people to revise the mode and extent of taxation, and obliterate the exaction of unnecessary burdens, especially upon the poorer classes, the question of the relation of the tariff to Canada forms a far more vital part of the programme than is generally supposed. If the expressed wish for change in the policy of the American people means anything, it means that there shall be no tax upon raw material, and that burdens on food supplies shall be obliterated. This affects a vast class of the people, and to a degree that nothing else affects them. Inasmuch as Canada can supply the two elements of raw material and food products to an extent greater than any other country, the consideration of the Canadian question in regard to the tariff is of prime importance. It may be doubted whether in the whole range of interests to be considered there is any one section which so affects the sources of supply, on the one hand, the opening of new markets, on the other, and in the end may be so fruitful of future consequences, and so potential in its effect on the continent at large, as the relation of the proposed new American tariff to Canada.

To a very large and intelligent group of thinkers in the country, the existing agricultural schedule of the McKinley tariff, which almost solely applies to Canada, is an instrumentality of great force in helping forward a movement toward a political absorption of the rest of the continent. This group of thinkers have it ingrained in their intelligence that the burdensome exactions of that tariff must, as they say, "bring the Canadian people to their senses," and compel them to realize that their interest entirely rests in the markets of the United States, and with an eventual alliance with the people of this country. Had the McKinley bill been constructed for the purpose of striking the greatest number of the largest class of industrial interests in Canada, it could not have been more skilfully framed. A wider application of disaster, so far as shutting Canadians out of best markets on the continent, could not be conceived in the productions of the soil, the forest, the mines, and the sea. The classes and interests most adversely affected are wide-spread and are resident in all regions, not only comprising the majority of the populace, but affecting practically the financial stability and the debt paying power of the entire community. It will serve a good purpose to illustrate just how far the agricultural schedule of the McKinley tariff has affected the most vital interests by the following table showing the agricultural exports to the United States from Canada in the two years 1890 and 1892 :

Articles.	1890.	1892.	Decrease.
Horses	$1,887,895.00	$1,094,461.00	$ 793,434.00
Horned cattle	104,623.00	21,327.00	83,296.00
Poultry	105,612.00	44,537.00	61,075.00
Eggs	1,793,104.00	494,409.00	1,298,695.00
Wool	235,436.00	200,125.00	35,311.00
Flax	175,563.00	112,360.00	63,203.00
Apples	149,479.00	27,661.00	121,818.00
Barley	4,582,561.00	1,354,485.00	3,228,076.00
Split pease	74,215.00	20,460.00	53,755.00
Hay	922,797.00	598,567.00	324,230.00
Malt	149,310.00	20.00	149,290,00
Potatoes	308,915.00	41,886 00	267,029.00
Vegetables	80,976.00	68,948.00	12,028.00
	$10,570,486.00	$4,079,246.00	$6,491,240.00

A decrease of seventy-five per cent. in the short space of two years in the exports of articles so essential as those above enumerated, in seasons when crops were good and prices fairly high, indicates a deprivation to the people of Canada of very great moment. These figures are significant of the paralysis which has occurred in other departments, as in shipping, transportation, mining, fishing, lumbering, and other great interests, and vividly illustrate the serious consequences of a restrictive policy upon the trade of the two countries.

It is a conviction in the minds of many intelligent people that, with such an object lesson as these figures teach so forcibly, the Canadians will soon sue for admission into the Union. Therefore it is urged that in the new tariff there shall be no change so far as it affects Canada. In the hope of territorial aggrandizement, in the expectation that half a continent will sue for admission into the Union, it is urged that existing exactions on free raw material and cheapened food products shall be continued; in other words, that there shall be no yielding to the demands for a better commercial relation between the two countries which a new tariff ought to bring about, and that, so far as concerns the commercial policy of both countries on this continent, a barrier to trade between them as high as ever shall continue to exist.

It is easy to say that the solution of the Canadian problem lies in the political assimilation of the people of that country into the United States, and in the annexation of its territory in the shape of eleven great States and territories. This is true, and to those who only casually examine the subject and are only partially informed the solution seems quite feasible, quite probable, and altogether desirable, even on terms of the greatest liberality. Yet to those who understand the Canadian people, and are familiar with the political, social, and commercial forces that prevail, both in the colony and in the mother country, annexation seems so far away that its possibility need hardly be considered as affecting the interests of the present generation. It certainly should not at this juncture be allowed to influence the new and enlarged commercial policy of the United States, if that policy has for its purpose the creation of a present trade continental in extent, yielding a present profit equally continental in its contribution.

To show the danger of such a policy, so far as the future trade of half a continent is concerned, and how independent Canada may become of the United States, the following table has been compiled, showing the steady decline in exports to the United States and a corresponding increase in the trade with Great Britain :

	Per cent. exported to United States.	Per cent. exported to Great Britain.		Per cent. exported to United States.	Per cent. exported to Great Britain.
1868	60.36	34.31	1889	43.58	53.34
1872	54.12	40.36	1890	36.50	60.08
1878	35.78	59.78	1891	29.28	66.21
1882	48.11	47.79	1892	16.78	77.28
1888	44.58	51.95			

The foregoing table indicates that in the last three years, while the McKinley tariff has been in operation, the commerce between Canada and Great Britain has grown with great strides, while that between Canada and the United States has lessened materially. It will be argued that the loss of the Canadian farmer by the decline in trade is the gain of the American farmer in the increased production and the higher price which he has been able to exact. But as against this it can be equally urged that the American consumer (numbering ten to every farmer) has borne the burden of the increased price, while the American farmer has had a competition in the foreign markets which his surplus seeks, which has resulted, with other causes, in such a decline of exports as to seriously threaten the whole commercial fabric of the nation.

In connection with the large proportionate loss of trade from the rest of the continent, indicating its future tendency under equally adverse circumstances, it is important to notice the movement among merchants and others which is now originating in the

United States in the direction of encouraging a political union between the two countries. This movement takes shape in the formation of a Continental Union League of merchants, manufacturers, bankers, and public men in the United States, to the number of 500 already secured, who, it is claimed, will give expression in an organized form to the popular sentiment of welcome with which the admission of Canada would be hailed. Such an organization it is claimed would greatly aid the growth of the annexation desire in the Dominion. This expectation may or may not be true, but it is an open question whether the exercise of outside influences is the policy of wisdom in the question as to the future political destiny of a people so sensitive and so self-reliant as are the people of Canada. Possessed as are the vast majority of them with a reverence for British connection bordering upon veneration; regarding as absolutely treasonable even the discussion of its severance; and realizing, as every one does, that any political change whatever is prompted only by material advantage,—it will be easy to interpret this outside influence, as proposed by the business men and others in the United States, as unnecessary, unwarrantable, and unwise.

This impression certainly will be the one created, should the influence of the proposed League, or the great power of its individual members, be exercised in Washington to keep in force the drastic provisions of the McKinley tariff, so far as it relates to Canada. It is easy to see that if, in view of a reversal of the trade policy which, by the direct vote of the people, the United States determined upon in the recent change of administration, there is a continuance as against Canada of the McKinley tariff, it will be regarded as a special slap in the face. If through the influence of the proposed Continental Union League, made up of the leading business men of the American cities, such a perpetuation of commercial hostility should be permitted, it would be one of the gravest mistakes ever made by an ill-advised body of most intelligent men. The consequence would be a resentment in the minds of the people of Canada against being driven by stress of circumstances into a political alliance which they do not covet, from one in which they are perfectly content, and this, too, by considerations of material advantage, denied to them except at the sacrifice of a sentiment occupying a place in their minds second only to the love of home and all it contains.

It may well be doubted whether any people can be allured into a political relation by the exercise of commercial hostility, and, if ever Canadians are to be brought into a closer relation with the United States, it cannot be by the principle of repulsion which the McKinley tariff contains. The breaking down of the barrier between the two nations, and the obliteration of the border line so far as trade and commerce is concerned, are much more likely to bring them closer together, and eventually unite them, than to keep up the barbed wire fence which now separates them. A union of interests is much more likely to beget union in sentiment, than a policy of isolation, selfishness, and commercial belligerency.

It would seem as if the commercial policy of the United States towards the rest of the continent might have other immediate purposes in view than territorial aggrandizement. The question of taking in the rest of the continent is one that can very well afford to rest for future decision in the presence of great problems that still confront this country, and it is a mistake akin to a crime that in the faint and distant hope of additional territory there should for a generation, at least, continue to be erected a barrier against expansion of trade in the North, and that there should continue the shutting out of needed supplies from that region.

Of course it will be impossible to have a freedom of trade on this continent, unless both parties agree to that principle. It is not for one moment to be considered that the United States should admit all the products of the northern half of the continent free, and that a high rate of duty should continue in that region against the manufactures of the United States into which these products find their way. The price for the freedom of admission into the United States must be that every article, of every name and nature, should have free admission into Canada.

It is true that the policy of the existing Tory government in Canada is opposed to that principle, and that, by its national policy of protection and the support of manufacturers, it maintains itself in power. But if the American government will offer to the Canadian people a free admission in the new tariff of raw material, natural products, and such slender supplies of manufactures as they can furnish, the return for which shall be the free admission into Canada of all manufactures that the United States can supply, the people of the Dominion will respond gladly in the affirmative to that invitation. During the last summer a convention of the Liberal party, representing the entire Dominion, assembled at Ottawa, the capital of the country. The party unequivocally committed itself to tariff reform, on the lines so broadly laid down in the recent presidential contest in the United States, and on the platform will appeal to the Canadian electors at the next general election, which will take place within eighteeen months. The party is likely to be successful, and a change in the administration of the Dominion is therefore imminent. Such a change would be in the highest degree advantageous to the United States. It would be rendered almost certain if the executive of this country, and those who are framing the new tariff, will make it possible that a practical Continental Free Trade shall be established between the two countries. The barriers against the growth of commerce will be broken down, so far as Canada is concerned, and the possible area of the trade of both countries will be at once doubled. A greater step will thus be taken towards the practical assimilation of the people that together possess the continent in common than by any other act now possible. The foundation will thus be laid for the adjustment of all the troublesome problems that arise between the two countries, because in the tariff arrangement between the two nations can be included the settlement not only of interstate transportation questions, and of the Fishery trouble, but of all other topics needing adjustment, and that solely by concurrent legislation, and not by diplomacy in which England is concerned. This would be achieving a continental union, not political in its immediate effect, but commercial and profitable to all concerned. As to its results on the political future of the continent, these can be left to the logic of events.

THE VALUE AND INFLUENCE OF LABOR STATISTICS.

By Carroll D. Wright.

THERE are now in the United States, besides the national Department of Labor, thirty-two State bureaus or departments devoted to the collection of statistics of labor by means of original investigations. Besides, the federal Census Office, the bureaus of statistics of the federal Department of State and the Treasury Department, the State and federal departments of agriculture, and various other offices may be considered as publishing labor statistics in part. But I speak here of the value and influence of those offices first mentioned,—those devoted specifically and technically to the investigation of social and industrial conditions and to the publication of distinctive labor statistics. These offices had their foundation in the establishment of the Massachusetts bureau in 1869. Gradually other States created bureaus of statistics of labor, and in 1884 the United States government added its own office to those already in existence. All the offices, together, have published nearly two hundred octavo volumes, covering a great variety of topics and the results of investigations relative to almost every condition and environment of the working-man.

The character of the work of the different offices varies in some degree, due to a considerable extent to the short tenure of the heads of the different bureaus. Where the governor of a State has allowed himself to ignore politics and insist upon scientific work, the bureaus have achieved the greatest success; but as a rule a governor feels that the office of the chief of the bureau of statistics of labor of his State must be filled by somebody from his party, without reference to the skill, the experience, or the integrity of the incumbent under the previous administration. Yet I am glad to say, as the result of pretty careful study of the reports of all the officials who have done duty in this country during the past twenty-four years, that no matter for what reason they were appointed, no matter how inexperienced in the work of investigation and of compilation and presentation of statistical matter, no matter from what party they came, and whether in sympathy with capital or with labor, and even if holding fairly radical socialistic views,—the men have, almost without exception, at once comprehended the sacredness of the duty assigned them, and have served the public faithfully and honestly, being content to collect and publish facts without regard to their individual bias or their individual political sentiments. As soon as a man realizes that he is giving to the world a fact, he feels the necessity of accuracy, and that to distort the information collected would be to commit a crime worse than any ordinary lying, because it would mislead legislators and others and fix a falsehood in the history of the State. Many men, too, have come into the work of the statistical bureaus feeling that they could use them as the means of propagandism in some way, and in a few cases this has been attempted, but almost always with failure, because bureaus are looked to to furnish information relative to actual conditions surrounding industry.

That what I have said is true is emphatically illustrated by other countries following the example of the American States. France, Belgium, some of the German States, England, New Zealand, and some of the Scandinavian countries have already established bureaus or departments following in their duties very closely those assigned by law to the American bureaus and departments. A distinguished member of the House of Commons of England told me a few years ago that, whenever he wished to lay any facts relative to working-men before his colleagues, he always had to carry into the House a copy of some American report on the statistics of labor. In the Chamber of Deputies of France, in the German Reichstag, and in the legislative bodies of other countries the American labor reports have been freely used in the economic discussions of the past ten or fifteen years. Had the American offices been failures, these things would not have occurred. It is true, of course, that the sentiment of the times is largely conducive to the successful operations of bureaus of statistics of labor. The general attention paid to social and industrial conditions and all conditions affecting the environment of men has fitted the soil for statistical seed. The altruistic spirit of this age calls for accurate information, that it may know how best to expend its efforts and not dissipate its energy. The question is constantly being asked: "What do social classes owe to each other?" and that any one class may not be deceived in the nature or magnitude of its debt, it must turn to statistics to ascertain the true situation.

The question is often asked, and by very intelligent people, Of what good is a bureau of statistics of labor? Does the workingman secure any direct benefits from its existence? This question cannot be answered very specifically, any more than could one asking for the direct benefits of the public school. It would be a difficult process to show how a dollar more is made to enter the pockets of the working people through the existence of the public schools, or any other educational institution, and yet all men will admit that the sum of benefits is largely increased by the existence of schools. Personally, I have always contended that the bureau of statistics of labor, wherever it exists, is simply a part of the educational machinery established by the community through which it is enabled to know more of itself. "Know thyself" is an injunction which should be applied to communities as well as to individuals, and it is only through rigid, impartial, and fearless investigations that any community can know itself in many directions. Notwithstanding this general view of the educational influence of the offices I am considering, very many instances of their specific influence can be cited. These instances I must, for purposes of convenience, draw largely from those which have come under my own observation or within my knowledge, for to enter upon a research of all the influences which have come in direct ways from the services of all the offices in existence in this country would take me too far afield.

One of the first results that I remember, as being traceable to a published report, related to the tenement-house system of the city of Boston. In the second, third, and fourth reports of the Massachusetts Bureau of Statistics of Labor there were many facts showing the condition of the tenement-houses in the city named. The public was fully apprised of the misery that existed in them, resulting from bad conditions, ill construction, and all that tended to make tenement-house life an evil. Public attention was aroused through these publications, better laws were framed and passed, and a public sentiment created which crystallized in a reform movement having for its purpose the improvement of tenement-houses in Boston. Some of the worst places were improved, and the impetus then given is still active, as is shown by the existence of societies in that city and their influence in securing from the legislature two years ago an appropriation to enable the bureau in that State to make a very exhaustive investigation covering every tenement of whatever grade in the city of Boston.

The bureaus everywhere, wherever conditions warranted it, have investigated the subject of child labor and shown to the public all the facts connected with such employment, the evils it entailed upon the community, and the methods which could be resorted to for its reduction, and everywhere, too, the results have been beneficial. If the bureaus had never accomplished anything else than the marked reduction in the number of young children—those under ten years of age—who are employed in factories and workshops, they would have amply repaid the public for its expenditure in their equipment and support.

The publication of information relative to the inspection of factories and workshops in England and other countries, together with statistics showing the necessity for such inspection in this country, has led in several States to the establishment of boards of factory inspectors. These boards have committed to them the execution of all laws providing in any way for the benefit of those who have to work in any kind of productive establishments. These inspectors enforce the laws concerning the hours of labor, the employment of women and children, the guarding of machinery so that the operatives may be more free from accidents, and in all ways undertake the enforcement of all laws of the character specified. Through these efforts (and they were largely induced by the reports of labor statistics) child labor has decreased, accidents have been reduced in number and severity, the hours of labor have been shortened and the necessity of the reduction recognized, and so all along that line of facts the influence of the reports of the offices we are considering has been enormous ; the value of their statistics cannot be expressed by figures.

The first ten-hour law in this country was passed by the Massachusetts legislature in 1874. The statistics published by the bureau of that State helped the passage of the law in a marked degree, and they saved it from repeal in later years. The manufacturers, finding that they were brought under the ten-hour law so far as minors and women were concerned, felt that the manufacturers in surrounding States ought to be brought under like laws or else the law of Massachusetts should be repealed, for they claimed, as the claim was made in England years ago, that in working under a ten-hour law the manufacturers of Massachusetts were placed at a decided disadvantage relative to the manufacturers in the surrounding States ; so the legislature directed the Bureau of Statistics of Labor to investigate the subject of the hours of labor in that State and in the other New England States. The result of the investigation showed that, working under a ten-hour system, the Massachusetts manufacturers paid more wages than those in the other States, where eleven and twelve hours were the rule ; that they produced more goods on any basis that could be named, whether individually or per machine ; and that in every respect the Massachusetts operatives were under better conditions than those of the surrounding States. There has been no attempt since that report was published to repeal the ten-hour law of Massachusetts. On the other hand, other States have followed suit, until now that system prevails almost generally in the United States.

The bureaus have been very influential in securing a modification of the old common-law rule relating to the liability of employers for accidents occurring to their employés. Under this rule a workman cannot recover damages for injuries received through the carelessness or negligence of a co-employé, although a stranger might recover damages for an injury following the same carelessness or negligence ; as, for instance, under the old common-law rule, a brakeman on a train running perhaps 500 miles could secure no damages from a railroad corporation in consequence of injuries received through the carelessness or negligence of a switchman along any part of the line, although the brakeman knew nothing of the switchman, had no knowledge of his skill or capacity when he engaged with the company, and in no sense of the word, so far as reason is concerned, could be considered the co-employé of the switchman ; yet, as that common-law rule grew up before great industrial enterprises were established, judges had projected it and had ruled that in such a case as that just mentioned the switchman and the brakeman were co-employés, and therefore the employer could not be held liable. The agitation for a legislative change in this common-law rule in England resulted in the enactment of a law in 1880 changing or modifying the rule, and, in this country, the matter being taken up by bureaus of statistics of labor, several legislatures have been convinced of the justice of a change, and have therefore made it ; the dire results which were predicted as sure to follow the change of the rule have not followed. In this direction the bureaus have done a great service, not only to the employés of railroads and corporations engaged in productive industry, but in securing the public against the employment of incompetent men.

Another very emphatic influence which the bureaus have exercised is in the abolishment or modification of what is known as the "truck-store" system, or, as it is more popularly known in some parts of the country, the "pluck-me" method of store-trading. This system consists in the establishment of a store by the proprietors of a works for the supply of its employés. Formerly the prices charged at these stores were much higher than those charged at other places, and so the employé of a concern having a truck-store was almost compelled, and in many instances actually compelled, to purchase the necessaries of life for his family at an exorbitant price, whereby the employer made a second profit on the labor of the employé. In very many instances the workmen of such an establishment never saw any money from one year's end to another. The pay for the goods purchased in the store was secured by the pay-rolls, and the debts and credits left no margin on pay-day. Early in the existence of bureaus of statistics of labor this system was attacked through the statistical method, and the result has been that in very many States laws have been passed making it a criminal offence, in some cases, to carry on such a system, and in other cases making it the duty of the proper officers to see to it that they are regulated. The evils of the truck store system have not yet been entirely eradicated in this country, but the change during the last fifteen years has been great, and the value to the wage-receiver of the greatest importance.

In this connection I might mention the influence which the bureaus have had in securing more frequent payments for the working-man. Formerly the payments were monthly. Under this system the credit system grew also, because without ready money the wage receiver must secure credit of his grocer, and the grocer, under such circumstances, looks out that the charges are sufficient to cover the delay in receiving his money or the losses which may come through his endeavors later on to collect the amount of his bill of the employer through the trustee or the garnishee system. Weekly payments have been shown by various bureaus to be beneficial in eradicating some of the evils of the credit system.

In some of the western States there have grown up during the past few years some of the most rascally practices on the credulity of the working-man that have ever been known. They are robberies of the meanest sort, for they not only rob a man of his money, but in many instances of his manhood. The practice I refer to is that of a certain class of employment-offices, located usually in the rear of some beer-saloon, which advertise that a large number of men are wanted for labor in a certain city, but almost always at a distance. In a western city one of these offices advertised for one thousand men to proceed immediately to Washington, D. C., where employment would be furnished at $1 per day. Hundreds of men responded to this advertisement. They were obliged to pay down $3 or $4, as the case might be or as the rascality of the manager might demand, and then the men were put off by various excuses for several days, until they began to clamor for their contract. When they became too demonstrative, the manager would pay back a part of the sum advanced, for the sake of integrity. Meantime, however, these hundreds of men, loafing about his beer-saloon, had expended more or less money for beer, in addition to the fee paid for the supposed employment. In one city an advertisement appeared for a large number of men to be shipped to Iowa, while in Iowa an advertisement appeared for a large number of men to be shipped to the very place of the first call. The bureaus in some of the States where such practices have been carried on have collected the information relative to these offices, and have exposed the swindle perpetrated upon the wage receiver. Much good is being derived from these reports, and it is confidently expected that, in addition to the laws already passed, others of a more stringent nature will follow and the evil practice be eradicated.

These instances of the direct influence and value of bureaus of statistics of labor are sufficient, it seems to me, to prove beyond any question their right to exist, their right to the sympathy and support of the public, and their right to ample equipment and means for carrying on their beneficent work. But they have another office to perform, which is one of the leading offices of statistics in every direction, and that is the correction of false impressions and the removal of apprehension, and two or three instances of this kind may perhaps be of service.

The statement is usually made by writers on the labor question from the capitalistic point of view that the prosperity of the savings-banks of the country represents absolutely the prosperity of the working-man,—that the total amount of savings in such banks clearly indicates the prosperity of labor. I am not disposed to question this statement, so far as it applies as a principle, but I question the degree of accuracy contained in it, for the investigations of the Massachusetts bureau have clearly shown that only about one-half of the deposits in the savings-banks of that State, in which the savings-bank institution has flourished for many years, and prospered, too, belong to men and women engaged in manual labor or in the toil necessary to the production of goods. Such a fact, properly brought out, simply sets people's thoughts in the right direction, although it does not disprove the sentiment underlying the erroneous statements regarding the conditions involved.

In 1878 a great deal was said about the unemployed in this country. It was reported, and the report was very industriously circulated, that there were from 200,000 to 300,000 people out of employment in Massachusetts, 40,000 in the city of Boston alone, and 3,000,000 in the United States. These figures were quoted in newspapers, works on political economy, speeches in Congress, political resolutions, etc., until they came to be believed everywhere, and yet no attempt was made, officially or otherwise, to ascertain the real facts. The Bureau of Statistics of Labor of Massachusetts undertook to make an investigation of the subject, and this it did at two separate canvasses, one in June, 1878, and the other in November of the same year. The result showed that in that commonwealth, on June 1, there were 28,508 skilled and unskilled laborers, male and female, out of employment, seeking and in want of work, and that in November there were not more than 23,000 of the same class. On these bases, there could not have been over 460,000 unemployed able-bodied men and women in the United States, ordinarily having work, out of employment at the time mentioned. The report further showed that in the commonwealth mentioned there were in 1875 only 316,459 persons engaged in manufactures and mechanical industries, in occupations upon which they depended for support, whether actually employed or not, and the whole number actually employed in the manufacturing and mechanical pursuits of the State was 308,963. If, therefore, there had been 200,000 or 300,000 persons out of employment in the State in June, 1878, as the alarmists were in the habit of stating, there could have been hardly any left in the factories and work-shops of the community. The figures published by the report were used all over the country, and completely reversed the popular belief relative to the vast number of the alleged unemployed in the country.

But I think one of the most striking instances of the removal of false impressions from the public mind relates to mortgage indebtedness on real estate. In a speech made in Congress in May

1888, the statement was quoted from an agricultural paper that the estimated mortgage indebtedness of all real estate in Ohio at that time was $701,000,000 ; in Indiana, $398,000,000 ; in Illinois, $620,000,000 ; in Wisconsin, $250,000,000 ; in Michigan, $350,000,000 ; in Iowa, $351,000,000 ; and statements were made for other States. The Ohio and Michigan Bureaus of Statistics of Labor undertook to investigate this subject, through the offices of the registers of deeds, the boards of assessors, etc., and in these two States the mortgage indebtedness, as established and estimated by the Commissioners of Labor, was, for Ohio, $330,999,205, and for Michigan, $129,229,553, instead of the amounts popularly claimed. Under the federal census of 1890 an investigation has been made relative to mortgage indebtedness, and the facts established with remarkable accuracy for the other States just named. By the investigation of the census it is shown that in Indiana the mortgage indebtedness is $110,730,643; in Illinois, $384,299,150; in Wisconsin, $121,838,168 ; and in Iowa, $199,774,171. It is a little remarkable that the sums accepted in a popular way for the mortgage indebtedness of the States named were in some instances exactly the valuation of all the property of the State. The extravagant figures quoted were used all over this country and in Europe, wherever capitalists were seeking investments in this country. The figures did immense harm ; the wrong cannot be calculated ; but as time goes on the statistics emanating from bureaus of statistics of labor and from the Census Office are removing the apprehension which grew out of the original statements.

Another feature relative to mortgages relates to the causes for which mortgages are placed upon farms in the western country. It has been claimed in recent years that the great mortgage indebtedness of western States is due largely to disaster or adversity. The Commissioner of Labor of Nebraska undertook to satisfy himself, by positive investigation, as to the truth or falsity of such claims, and he took as the territory for his investigation the county of Sarpy, covering the period from December 31, 1879, to January 1, 1890. Sarpy is one of the oldest counties in Nebraska, and it therefore offered the best opportunities for investigation in that State. The result, as to the causes for the creation of the mortgage indebtedness of the county, is shown in the following statement, taken from Commissioner Jenkins's report for 1889–90 :

Purchase money..	58.	per cent.
Permanent improvements...................................	3.	per cent.

Purchase of stock	4.	per cent.
To meet personal obligations	.5	per cent.
To invest in real estate	7.	per cent.
To invest in mercantile business	20.	per cent.
Sickness	.25	per cent.
Unknown causes	7.25	per cent.

Allowing that all the mortgages from sickness and from unknown causes were the result of misfortune or of adversity of some kind, the foregoing table shows that 92½ per cent. were for legitimate causes, and such causes as indicated prosperity rather than adversity.

The investigation under the eleventh United States census comprehends the object of indebtedness for 102 selected counties in several States, the results being obtained by personal inquiry through the experts of the office. That investigation is a clear and emphatic corroboration of the results arrived at by Commissioner Jenkins of Nebraska. It shows that to legitimate objects, indicating clearly prosperity and advancement, 94.37 per cent. of all the mortgage indebtedness of the 102 counties considered must be attributed.

These few instances show the enormous value of statistics in removing apprehension and in correcting erroneous views. The money value of such information is too great for ordinary calculation.

Notwithstanding all that I have said relative to the value and influence of the statistics of labor, I am perfectly well aware that they could be made of far greater value; but that greater value can only be secured through the direct action of the legislative bodies behind the bureaus. They are very poorly equipped. They need more men and more money. They need experience, which can only come through the influence of the executives of the States. With an enlarged tenure of office and an increase in the equipment and means of the bureaus, their future usefulness can be made to far excel that of the past and of the present. The lines of work which they can undertake are numerous and inexhaustible. Knowledge of production is absolutely essential for the adjustment of many of the difficult questions we are facing to-day, and any contribution, through statistical investigation or otherwise, that will enable both the capitalist and his employé to more clearly understand the real conditions of production should be welcomed by all elements of the community. The bureaus must be kept in the future, as in the past, free from partisanship. The statistician is not a statistician when he is an advocate, no matter how skillful he may be in the manipulation of figures. He must be impartial, he must make his investigations without any reference to theories to be proved or disproved, and give to the world the actual results of his inquiries. This country lacks trained statisticians. We have no means for training them, except in the practical work of the statistical offices of the State and federal governments. These offices, therefore, become a school for the future, and the statisticians of this country that are to be of great service to the governments must acquire their knowledge through the statistical offices ; but no work can be accomplished successfully without money and without men. We must look, therefore, to the legislative branches of our various governments for the increase of the usefulness and for recognized influence of our bureaus of statistics of labor.

THE WIDENING USE OF COMPRESSED AIR.

By Whitfield Price Pressinger.

ALTHOUGH considerable attention has been devoted of late in the technical press to compressed air and improved types of air-compressing machinery, few have paused to consider the multiplicity of duties to which this power is applied, and the variety of work in the successful performance of which it is an important factor. This development is interesting in a general point of view as a feature of modern progress, and the control of this air, which the child uses to actuate his pop-gun and the aborigine in Thibet employs to produce light, is fast becoming a power in the commercial world.

Compressed air, utilized for power purposes, either locally or at a distance, has been known to the world for nearly two hundred years, Dr. Peppin, an eminent French engineer, having conducted some experiments with it in the early part of the eighteenth century. It has been more or less identified with almost every prominent engineering work in America in modern times, furnishing as it does a means of transmitting power a long distance from its source, without the heavy losses from condensation attendant upon the use of steam ; or supplying the power for sinking a bridge caisson without interfering with the duties of the workmen inside ; or permitting mines to be worked at levels where the use of steam would be impracticable, the exhaust air having a marked effect upon the temperature of the mine. But the employment of compressed air for sinking bridge caissons, operating rock-drills, coal-cutters, and other mining machinery, manipulating air-brakes, tunnel-driving by the pneumatic process, etc., are familiar ones and passing mention of them will suffice in a summary of the various uses which have been devised for this power and the service it is performing for the engineer, scientist, and manufacturer.

The pneumatic dynamite gun is a familiar example of the duty which is made possible by air under pressure. The pent-up energy which, when released under a pressure of 2000 to 3000 pounds per square inch, hurls a projectile containing 500 pounds of nitro-gelatine and dynamite through a mile of space in eighteen seconds, with an initial velocity of 800 feet per second, is a powerful factor in the art of war.

Another employment of comparatively recent development,—but designed for the preservation, not the destruction, of life and property,—is the pneumatic device for block-signaling. In this duty the compressed air is supplied from a central station and each semaphore or signal-arm is operated by a separate cylinder and gear fitted to the signal-post, the valves of the apparatus being controlled by electricity. In some instances the air is carried in two-inch pipes to a distance of nearly eight miles from the point of supply, the pipes on the main road being supported on stakes along the track. When it is necessary to pass through yards the pipes are carried underneath the ballast of the road. The air-pressure maintained is about sixty pounds per square inch.

The method of raising water from deep wells by means of compressed air is one that has recently commanded attention, and many of our largest factories and mills have discarded deep-well pumps and become dependent upon their air-compressors for their entire water-supply. Indeed, so successful has been the work done by this system of raising water that one manufacturer whose neighbor had introduced it found his entire water-supply diverted and was compelled to adopt the compressed-air method or close his works. The plan is that of the siphon and consists of little else than two plain parallel iron pipes inserted into the well, one acting as an inlet for the compressed air and the other serving as an outlet for the water, which is expelled in a solid column. The pressure of air used is of course directly proportionate to the depth of the well. Results differ as to the exact saving in power and repairs in comparing this method with the best deep-well pump practice, but in an individual instance a daily water-supply of 300 gallons was secured against a former possible supply of 75 gallons. The average efficiency of the deep-well pump is 30 per cent., whereas as high as 70 per cent. is claimed for the compressed-air method.

The utilization of crude petroleum for fuel purposes affords another example in which compressed-air is highly necessary. The air is used at a pressure of ten to fifteen pounds per square inch, and sprays the oil into a jet at the point of consumption. This system is utilized in about fifty different varieties of work, such as iron- and steel-forging; tempering, welding, annealing, making tin-plate; for furnaces, glory holes, lears, and ovens; in glass- and pottery-works; japanning, and heating retorts in gas-works. In all of these plants the air-compressor is a very important adjunct, for without it they cannot be operated.

The chemical manufacturer finds compressed air a valuable servant in emptying tank-cars containing acids, and forcing their contents to various parts of his works. He also employs compressed air to agitate and cool his solutions. The sugar interest is also a large user of compressed air for agitating and cooling syrups.

In india-rubber factories the hose is removed from the iron mandrels by forcing a current of air under fifty to sixty pounds pressure between hose and mandrels, thereby inflating the hose, and permitting it to be easily slipped off. The hose-manufacturer also uses compressed air for testing his product, a test as high as 1000 pounds pressure per square inch being demanded on some varieties. A new plan which has lately been adopted in silk-mills is the spraying of solutions on silk ribbon by means of compressed air under forty pounds pressure. This system is highly successful, as it possesses many advantages over old methods and is rapidly being introduced by the manufacturers.

Pneumatic riveting-machines are to-day used in all construction works of any size, this being another form of operating with compressed air, where the exhausting steam would render the use of the latter impossible. In the same manner compressed air is used in boiler-shops for operating tapping- and calking-tools and portable drills. It is being widely introduced into monument and architectural stone-works for operating pneumatic carving-tools, the latter being immeasurably superior to hand tools, both in the saving of time and in execution.

Pneumatic cranes and hoisting-machinery open a very large field of usefulness for compressed air, for establishments are found in every branch of trade equipped with apparatus of this description. As an instance I would mention the Armour abattoir, in Kansas City, which conveys animals through all the various stages of slaughtering, cleansing, dressing, etc., entirely by this method; and many other industries employ it to a like extent. The piston-and- cylinder hoist, with its various modifications, is used.

The numerous systems of pneumatic tubes for transmitting mail matter and other parcels by air pressure have been too thoroughly described to require more than mere mention, but the plant installed in the Philadelphia Post-office is only an entering wedge to what, it is believed, will eventually be adoption by the government. In this service we are far behind our foreign cousins, who have had numbers of such plants in operation in London, Paris, Berlin, and other cities for years, there being about fifty miles of such tubes in Great Britain alone.

Among the oldest forms of employment of compressed air, are those to be found in refrigerating and ventilating. Ammonia has supplanted air for the former duty, but the various new systems and improvements of old systems of ventilating recently introduced bid fair to solve the problems which have so long vexed ventilating engineers and incidentally to bring compressed air into further prominence as a servant and benefactor of mankind.

The propulsion of cars by compressed air is another source of utilization of this power which has received the attention of engineers for some years past. The Mekarski system, which has been operated so successfully in Paris and other European cities, has been introduced into this country, and the Judson, Kames, and other systems are more or less known. A compressed-air motor needs no conduits or overhead contrivances, does not emit smoke or hot gases, and is almost noiseless. It is very light and can easily be handled on the steepest grades. It is simple in form and does not frighten horses, the machinery in front being almost invisible from outside. With the increasing efficiency of the best types of air-compressors, and the resultant economy in compressed-air production, the cost of this system is gradually approaching the most favorable comparison with other methods of street-car propulsion.

A recent application of an old principle is a pneumatic culm-conveyor, designed to remove culm from the coal-breaker and convey it to any desired point by directing a current of compressed air into the receiving pipe. If the air be heated it performs the further duty of separating the dust from the small pieces of coal. Pneumatic grain-elevators, operating on a similar plan, have been used to a considerable extent in England, and to a less degree in this country. A plant of this kind at Birmingham has tubes of various dimensions, and a capacity of twenty-five to sixty tons per hour. The chief feature consists of the peculiar-shaped nozzles through which the grain is drawn and forced upward at an enormous rate. Operating under forty pounds pressure the grain is raised to a bin at a height of forty feet, descending thence into a weighing device. The cost of unloading grain cargoes by this method approximates four to six cents per ton.

The system for the disposal of sewage by air under pressure has palpable advantages under certain conditions. In the plant at the World's Fair, with which many of my readers are no doubt familiar, the territory is divided into sections, each having its own ejectors, into which it drains. These ejectors operate alternately, the pressure being turned on and off by automatic valves and the contents forced to their destination through cast-iron mains.

Another utilization of compressed air at the World's Fair was that of painting the large buildings by means of a spray, the air forcing the paint through a hose to a nozzle which is handled by the painter instead of his brush ; playing away at the object to be painted much after the manner of the gardener on the lawn. In the dome of the Horticultural building the painter stood about seventy feet above his source of supply, and a large amount of space was covered in an incredibly short time by this method.

The Australian sheep-shearing machine is another mechanical device operated by compressed air. It is claimed for this machine that a hundred sheep can be sheared in the time formerly required for seventy, that the value of the wool is enhanced by its use, and that the animal is never mutilated. It operates at forty pounds air-pressure, and makes 6000 revolutions per minute, the exhaust air preventing the generation of undue heat.

An application of another old idea depending upon compressed air for its success has recently been attempted,—that of raising sunken vessels by placing collapsible india-rubber bags in the hold of the vessel and connecting these bags by means of hose to an air-compressor located upon a tug at the surface. When the bags are inflated to a pressure of sixty to eighty pounds per square inch it is claimed that enough water is expelled from the hull of the ship to restore very nearly its original buoyancy. The schooner *Glenola*, sunk off the Long Island coast, was recently raised by this method. It has been proposed to adapt this same principle to all new vessels by dividing each ship into air-tight compartments, with doors properly packed, each compartment being supplied by a tube from an air-compressor. With a suitable system of switches the water could be ejected from any compartment, should a leak become manifest on an electrical indicator in the switch-room.

In the purification of a city's water-supply compressed air is used largely. A plant was installed by Professor Leeds at Hoboken, in 1884, the air being used at 128 pounds pressure. Since that time companies (now merged into one) controlling the various existing methods of purification have established plants in many cities and towns in the United States.

A large number of experiments with compressed air are continually being tried. Among the uses which have never been reduced to the practicability of commercial requirements, I am reminded of an experiment which was tried some years ago, before the small steam racing crafts of to-day were contemplated. A steamer was seen one day to pass through the Kill von Kull at the then extraordinary speed of twenty-five miles per hour. This was accomplished by means of two air-compressors pumping air beneath her hull, thereby imparting great buoyancy. Unfortunately the swell from her rapidly-revolving paddles was so great as to wash over piers and wreck small boats, and it was even alleged that it injured oyster-beds in the vicinity. A drag was adopted to keep down the swell, but the expense of operating in this manner was too great, and the project was abandoned.

In addition to the various applications of compressed air already enumerated, it is employed to operate the steering-gear of vessels, to supply divers in submarine operations, to mold patterns in foundries, and a western railroad is reported to clean the seats of its passenger-cars with jets of compressed air. Physicians use air largely for treating patients by means of a spray, and hospitals are equipped with chambers in which the patient breathes air pumped in at a pressure of thirty to forty pounds per square inch In some of our large buildings any depreciation of pressure on the hydraulic-elevator tanks is replaced by means of compressed air.

In fact, there seems to be no limit to the employment of this power, and inventions in the success of which it is an important factor, and new methods of performing old tasks which it renders possible, are continually being introduced. And with the recent improvements in the direction of increasing the economy and efficiency of the prominent types of air-compressing machinery, and the further advantages realized from developing increased power by re-heating the air, many foresee the era when a central plant will be established and a compressed-air main will be situated under every street, operating mills and factories as in Paris and Birmingham ; ventilating buildings in summer and warming them in winter ; preserving perishable merchandise in cold storage ; operating elevators, grinders, pumps, saws, printing-presses, lathes, and the countless other machinery of commerce. Others even go further and look for its introduction into houses, the same as gas and water, for ventilating, for warming in winter and cooling in summer, and for operating lifts, sewing- and washing-machines, and even clocks.

In compressed-air we have a power ever ready to do our bidding, summoned or dismissed by the simple turning of a valve. It operates in place of steam without the least change of plant, obviating the employment of engineers and firemen, doing away with boilers and their accompanying disadvantages of waste steam, smoke, ashes, dirt, dust, risk of explosion, disagreeable odors, the expense of cartage, increased rates of fire insurance, water tax, etc. The old maxim that "importance oft attaches to trifles light as air" becomes doubly true when we consider that this atmosphere, always so necessary to human existence, is being concentrated and harnessed to the service of mankind in so many new and widely-different ways.

THE IRON-ORE REGION OF LAKE SUPERIOR.—I.

By Richard A. Parker, C. E.

THE iron-ore fields of the Lake Superior region, in the United States, are so extensive in area and so rich in their deposits, as to have become a factor of the greatest importance in the iron-making industry of the whole world. In treating of them at considerable length in these pages, therefore, it is not as if a local interest were being described, but rather one in which every great nation has an interest. The iron zone extends from the meridian passing through Chicago westward to the Pokegama Falls of the Mississippi river, a distance of about two hundred and fifty miles. The ore-bearing rock-series traverse the western half of the Upper Peninsula of Michigan, the eastern half of Wisconsin, and extend about eighty miles in Minnesota.

There are five iron-ore "ranges," one of which (the Marquette) lies wholly within the boundaries of the Upper Peninsula. Two (the Menominee and the Gogebic) are partly in Michigan and partly in Wisconsin, while the other two (the Vermilion and the Mesaba) lie wholly in Minnesota. The order in which the ranges are named corresponds to the order of their discovery.

THE MARQUETTE RANGE.

The history of the first find of iron ore in the Lake Superior region is fraught with much interest; and, as is usual in such cases, some question exists as to whom the honor of priority of discovery belongs. The earliest authentic knowledge of its existence is doubtless recorded in the papers of Mr. W. A. Burt, a surveyor, who in 1844 was engaged in establishing township lines and making geologic notes. On September 19, 1844, while running the east line of township 47 north, range 27 west, in Michigan, he observed by means of the solar compass "remarkable variations in the magnetic needle, amounting to 87 degrees from the normal."

On the other hand it is claimed that iron ore was known to exist, as far back as 1830, to the white traders who, in their search for furs for the American Fur Company, traveled over the hills and mountains, and doubtless did see the outcropping masses of ore glistening in the sunlight. The Indians doubtless also were aware of its existence, but not of its value or the means whereby it could be made serviceable to them.

In 1845 a half-breed, Achille Cadotte, was told by an old Indian chief, Mar-di-me-sik, then living at the mouth of Carp river near the site of the present city of Marquette, that he knew of a mountain of iron and went with him to see it. Cadotte afterwards informed Mr. P. M. Everett, of Jackson, Mich. (one of the incorporators of the Jackson Company, which was organized to operate in the copper district), who made an effort to locate the ore, but failed. Upon Mr. Everett's return to the mouth of Carp river he fell in with the Indian chief, who piloted the party to the Jackson mountain and also to what is now known as the Cleveland mine. Some 300 pounds of this iron ore was "packed" down to the Lake and carried to Detroit and Jackson, as specimens. Some also was sent to Pittsburg to be tested, but it was pronounced worthless. This was probably because more or less of the jasper in which the ore occurs was associated with it, as other portions from the same lot yielded a small bloom, which Mr. Everett had made into a knife-blade.

In the fall of 1846 the Jackson Company began mining development, and in the summer of the same year commenced the erection of a forge upon the Carp river, about three miles east of Negaunee. The forge was operated upon Jackson ore, but ran only a few days after being started, as a freshet washed the dam away. It was started again in the fall and ran successfully for a short time, making four blooms daily from two fires; each bloom was about four feet long and eight inches thick. The forge was kept in operation until 1854, when it was abandoned. Another forge was built at Marquette just south of the shore end of the merchandise pier in 1849, under the direction of A. R. Harlow, Esq. It was destroyed by fire the following winter and never rebuilt. Two other forges were subsequently built at Forestville and Collinsville. Though these furnaces were supplied with ore from the Jackson mine, but little progress was made in mining until after the completion of the company's dock in 1855; regular shipments, however, did not begin until the spring of 1856. The vessels in those days carried from 150 to 500 tons of ore, which was loaded into the holds by men wheeling the ore in barrows. The ore was carried by wagon from the mines to the dock over a plank road, which subsequently was converted into a tramroad, on which mules were the motive power. This road was used until 1857, when the first railroad for hauling iron-ore in this district was built.

The changes that thirty-five years of progress have wrought are little short of the marvellous: the plank road has given way to a finely equipped railroad, which hurries its load of 600 tons over docks into pockets which empty into the holds of vessels capable of carrying 3000 tons; mines, whose output then would be reckoned at a few thousand tons a year now are capable of shipping hundreds of thousands of tons each season; mines that yielded their ores at the surface and at times above the general surface level now are 600 to 1000 feet deep. Hoisting by a horse-whim has given place to elaborate hoisting-engines capable of exerting 1000 horse-power each. Little was then known in this district of the art of mining, as, at the time of the first discovery of ore, it is estimated, there were not over 50 white inhabitants within the present limits of Marquette county. To-day no country can show better methods or more efficient labor than is found in the Lake Superior district. The original methods were largely derived from English practice, but they have been modified to suit special cases and exigencies, each mine having its peculiarities in the disposition of the ore-body in the ground, character of the inclosing walls, or nature of the ore; all these are more or less variant in each property, and the economical and safe extraction of the ore is the problem to be solved by the local management. How this is done in some of the more prominent mines will be outlined.

All the ore beds, deposits, or lenses occur within the limits of what has been known as the Huronian series of rocks, by which term was included all rocks lying between the Laurentian below it and the Cambrian, or earliest fossiliferous rocks, above. Quite recently however, at a conference of the members of the U. S. Geological Survey, it was decided, owing to the impracticability of the certain correlation with one another of the one or more pre-Cambrian series which occur in the various regions, and since a uniform plan for mapping must be adopted, that a term of the same class as Cambrian, Silurian, and Devonian should be selected for rocks here included, and to occupy this place the term Algonkian was proposed and accepted; the Leewenawan and Huronian series together, therefore, now constitute the Algonkian which has heretofore been known as the Huronian.

On the Marquette range the Huronian rocks are divided into the upper and lower, in both of which bodies of iron-ore are found;

roughly speaking, the western half of the range belongs to the lower and the eastern half to the upper Huronian, while the ore beds and deposits of the Menominee, Gogebic, and Mesaba may be placed in the same division. The strategraphy of the Vermilion range corresponds closely with that of the western portion of the Marquette range. The deposits in and around Negaunee and Ishpening, which towns are respectively 12 and 15 miles west of Marquette, are usually found lying in a U-shaped basin of greenstone, with a marked pitch to the west. At others the ore is encased in a matrix of jasper, while at others slates form the foot or wall upon which the ore-body rests.

In plan the deposits are irregular and vary very greatly in width, ranging from a few feet to over 300 feet wide. Some of them outcrop at the surface, while others have to be prospected for underground either by means of cross-cuts in barren rock, drifts following small "feeders," or by diamond drilling either above or below ground. In the mines having lenticular masses, such as the hard specular or magnetic ore of the Champion, Republic, Michigamme, or Humboldt mines, the use underground of the diamond drill has been of untold value and importance, as by it the lenses which are separated often by many feet of tough, barren jasper are located definitely and access to them obtained in the shortest distance possible. As lenses do not usually have the same maximum width that is found in deposits of ore of a softer nature, it is necessary that the adjacent rocks must be thoroughly explored, so that they be not left in the ground ; if, however, lenses do not achieve greatness by their width, they do in the depths they attain. But what has been said is not intended to convey the idea that the deposits, *per se*, are shallow ; on the contrary, many of them reach to depths that challenge the deep-rooted lenses of hard ore.

None of the developed ranges have yielded the same amount or variety of iron-ore as that obtained from the Marquette range. Beginning its shipments early in 1856, in spite of depressions, panics, and the successive opening of other ranges, it has maintained a growth that is surprising even to those familiar with its history ; while the State of Michigan, which in reality should read Upper Peninsula of Michigan, as no iron ore of any moment is produced elsewhere in the State, stands first in the list of producers in the United States, as it has done for a great many years. The total iron ore mined in the State during 1892 was 7,543,544 long (2240 lbs.) tons or 46.29 per cent. of the grand total for the

United States, showing an increase of 1,416,543 long tons, or 23.12 per cent. over the 1891 product of 6,127,001 long tons of the State. Of the total for the State 7,228,406 long tons or 95.82 per cent. was red hematite, giving Michigan first rank as a producer of this class of ore, with 62.06 per cent. of the nation's red hematite total. The increase in the quantity of ore of this character over the 1891 output (5,445,371 long tons) was 1,783,035 long tons, or 32.74 per cent. The remainder of the output, consisting of brown hematite (187,306 long tons) and magnetite (127,832 long tons), showed a falling off from the 1891 output in these grades. This decline is doubtless due to the favor with which furnace men look upon the softer ores, which, it is claimed, require less fuel for their reduction in the blast furnace, and to the fact also that the harder ores require crushing before being charged; as this was an added expense, the softer ore had the advantage of this cost of crushing over the harder ore. At the mines where this latter grade of ore is produced, notably at the Champion mine, Michigan, and Minnesota Iron Company's properties in Minnesota, enormous crushers have been introduced, so that in the future the furnace will receive ore free from the objection of size and consequent difficulty of one handling, and an ore that contains practically no moisture.

The iron ores found in commercial amounts upon the Marquette range consist of limonite, magnetite, and the several varieties of red hematite; this last is an ore in which the iron occurs as an anhydrous oxid, giving a red streak upon a porcelain plate, the color being generally brownish red, or red, blue, purplish, and dark gray to black. This class includes "red hematite," "specular" (from its glistening scales which become detached easily from the ore mass), "micaceous," "slate" as well as "martite" (which is a pseudomorph after magnetite,—that is, it has the granular or crystalline appearance of magnetite, with the chemical composition of a hematite: it yields a red streak upon porcelain). Hematites shipped to lower lake ports vary in their iron contents from 58 to 68 per cent., when the sample is dried at 212° Fahr. At times these ores, owing to their plastic condition, absorb and retain considerable mine water, from 5 per cent. to as high as 17 per cent. When in transit from the mine to the docks, or when the ore is allowed to stand in the railroad yards, it is subject to the vagaries of the weather; a sharp shower of rain will add an appreciable amount to the weight of a car of ore; while, if the ore is allowed to remain in cars or the pockets of the dock during a warm spell, the loss

DOCKS AT MARQUETTE, MICHIGAN—LOOKING EAST.

of water by evaporation is considerable—enough at times to make a very serious discrepancy between the shipping weight at the mine and that at the receiving port. These differences largely balance each other however, so that at the end of the season there will be but a slight adjustment of the totals needed. Vessels upon leaving port have one per cent. deducted from the railroad weight, which is the bill of lading weight ; this is intended to cover shrinkage by desiccation, or loss by handling. Such a method appears crude and hardly in keeping with the care and scientific working given to other departments of mine operating.

The amount of magnetite mined is annually decreasing. This falling off is due almost entirely to the cost of mining the ore, the ore itself being hard and dense, usually incased in a matrix of jasper which is tough and hard, making it expensive to drive the needed gangways, or sink shafts. Still, the high furnace yield of this ore and crushing to convenient size will always permit the sale of its fair proportion. Years ago it was the standard ore, and prices of all others were based upon it. The magnetite ore, when pure, contains 72.4 per cent. of metallic iron ; the balance, 17.6 per cent., being the combined oxygen. Cargoes of this ore have been shipped which would analyze 69.0 per cent. in iron, with 3 per cent. of silica and carrying less than .03 per cent. of phosphorus. The Republic, Champion, Michigamme, Baron Humboldt, and Edwards (now Samson) are the mines that have been the more prominent producers of this grade of ore. Associated with and at times merging into magnetite is found the specular hematite, in these mines. In the Republican and Champion mines about an equal amount of each kind of ore is raised.

Of limonite ore there has in the past year or two been but little mined. It contains more water than a hematite, and therefore carries a lower percentage of iron, rarely if ever exceeding 60 per cent. Owing to its low metallic contents, but little is shipped to lower lake ports, as the freight paid would be largely for an abnormal amount of water ; for this reason, and the fact of its reducibility in the stack of a furnace, it is in demand by local furnaces. It is yellow to brown in color, soft, and often it is a self-fluxing ore ; that is, it contains the correct proportion of iron, lime, and silica to smelt and free the iron from the accompanying impurities ; being porous, the heat and reducing gases readily penetrate and reduce the ore to a metallic state. It is a low grade ore, and not a lean ore,—terms which are at times thought to be

CITY OF ISHPEMING, MICHIGAN—LOOKING SOUTH.

[Barnum mine workings in foreground,]

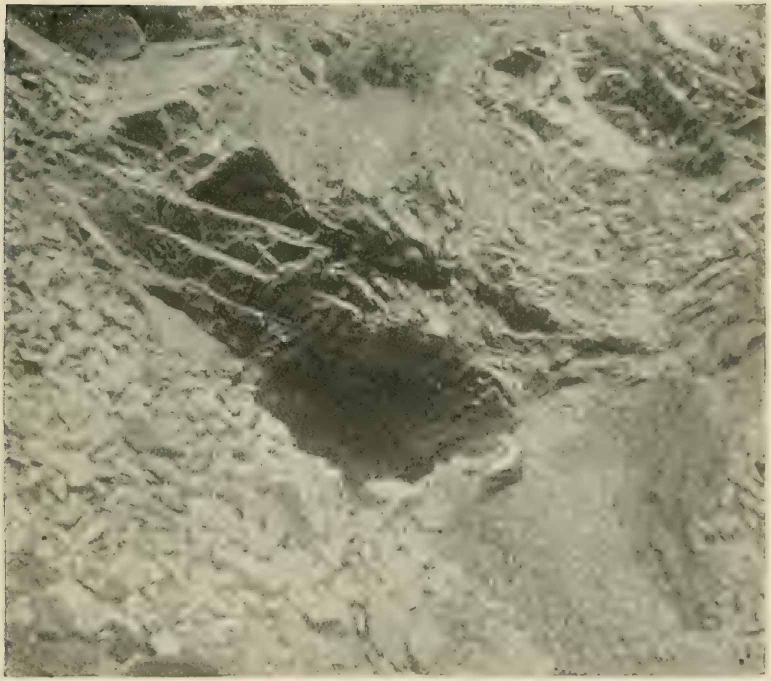
PIT OF BUFFALO MINE—LOOKING EAST.

synonymous. A limonite of this district may be taken as a typical *low* grade ore ; while a lean ore type would be found in the hematites carrying an abnormal amount of silica in the form of jasper or quartz. The former is reduced with a minimum of fuel, while the latter would demand an excessive amount of lime to slag off the silica, which in turn would call for heavy fuel consumption. There are times when a silicious ore is needed and used by furnaces, but only when a special grade of iron is wanted.

A list of the names of the mines having features of interest would embrace every mine capable of making an output of 50,000 or more tons of ore. The old Jackson at Negaunee is still operating ; also the Negaunee and the Buffalo group of mines lying southeast of the town ; the Volunteer at Palmer ; the Lake Superior, Cleveland Cliffs Co.'s several mines, the Lake Angeline, with its phenomenal deposits of high-grade hematite, the Mitchel and Winthrop, all in the town of, or adjacent to, Ishpeming. There the Humboldt, Republic, Champion, and Michigamme companies possess mines of hard ore which have made their names known throughout the iron world.

A technical or detailed description of the various methods employed for winning the ore from the ground will not be attempted here. The illustrations which accompany this article will give a fair idea of the nature of the improvements made upon the surface and the character of the machinery employed. Many of the mines of the iron districts have achieved considerable depth by the aid of this improved machinery, the deepest being the Hamilton mine upon the Menominee range, to which reference will be made later.

The removal of the water of Lake Angeline, about a mile south of the city of Ishpeming, has been an undertaking of considerable importance and value. A lake covering an area of 103 acres, and 45 feet deep at its deepest portion, was emptied of its water in order to permit the mining of the iron ore lying beneath it, and to



LOOKING NORTHWEST IN CAVED GROUND OF BUFFALO.

[Between old open pit and caved ground is shown cap-rock and foot-wall.]

do it with safety. So long as the water remained above the miners, it was a menace to them, and the only solution of the problem was to remove it. Various ideas were advanced, but finally it was decided to cut down the outlet as much as the topography of the country would profitably allow (about six feet) and pump the rest of the water. The water has been removed, but the remaining mud, which is in places over 30 feet deep, has been the source of some apprehension and will prove more difficult of removal than the water. The Lake Angeline mine is now engaged in mining by the caving system at the east end of the Lake, while the Lake Superior and Cleveland Cliffs companies have their ground, lying under the bed of the lake, all developed and explored, ready to make a very heavy shipment, so soon as the mud

BUFFALO MINE—LOOKING WEST.—NO. 2 SHAFT.
[Prince of Wales mine in distance.]

is removed and the condition of the market will permit sale of its ore. At the Champion mine in Michigan and the mines of the Minnesota Iron Co., of Minnesota, producing hard ores, the latest plant improvement consists of large 65-ton ore-crushers, built upon the general plan of the Blake rock-crusher. The opening at the mouth of the jaws is 24 inches by 24 inches, and ore is crushed down to 2½ inch pieces; to do this, an engine of about 100 horse power is employed; the crusher can break from 800 to 1000 tons every ten hours. The ore is run directly into railroad cars after crushing, whence it is shipped to the docks at Marquette, which are illustrated on another page.

The total output of the Marquette range since its opening up

LAKE ANGELINE (LOOKING WEST) BEFORE WATER WAS PUMPED OUT.

to the end of the year 1892 has been 37,924,968 long tons of all kinds and grades.

THE MENOMINEE RANGE.

The Menominee range occupies a position upon the southern boundary of the Upper Peninsula, midway between its eastern and western extremities. It lies for the most part in Michigan, but a few of its mines are in Wisconsin. The general trend of the range is north of west, and it is persistent and regular in its course. It is about fifty miles in length, twenty of them lying east of the Menominee river, the remainder west of it. The first location upon the range was made at the eastern end by the Breen brothers near the present town of Waucedah in 1866, but nothing was accom-

NO. 1 QUEEN SHAFT—LOOKING EAST.

plished towards establishing the value of the range until 1872. The panic of 1873 brought explorations to a sudden stop, and they were not resumed until 1876. In 1872 Dr. N. P. Hulst, chemist for the Milwaukee Iron Company, was sent to the range to develop and explore it; roads had to be surveyed and cut, camps established, and men obtained, so that it was not until the fall of 1873 that an ore of merchantable grade was found by explorers working under his direction. Three mines were found that year, the Breen, West Vulcan, and Metropolitan, when the panic stopped further development. To the Breen brothers belongs the honor of first finding ore upon the range, but to Dr. Hulst belongs the credit of systematically

LOOKING SOUTH-WEST TOWARDS QUEEN. OLD NO. 1 SHAFT, WHERE LADDER SHOWS.

and intelligently exploring it and giving to the Upper Peninsula this valuable territory.

The same general series of rocks are found in this as in the Marquette range, with the additional feature of Silurian limestone overlying the Huronian series, an occurrence not seen in the older range. The latter series pass under (near Breen) the Silurian rocks, but are not terminated by it. Running parallel with the range and north of it is a belt of dolomitic limestone, with an occasional break in its outcrop, and with a dip to the north ; filling in various

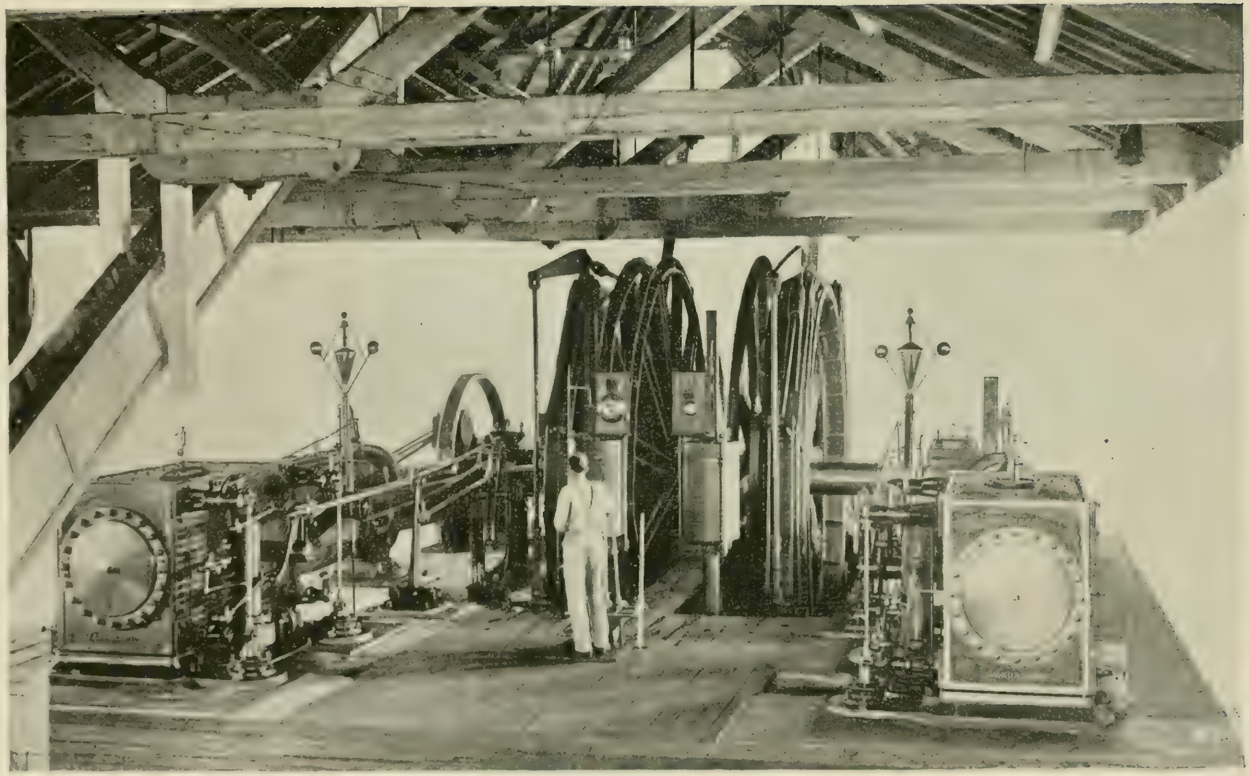
WATER DISCHARGING FROM SMALL BALER OF LUDINGTON MINE.

[Chapin workings in the distance.]

LAKE ANGELINE, LOOKING WEST, AFTER MAIN BODY OF WATER HAS BEEN PUMPED OUT.

[Cleveland Cliff Company's lake shaft on the extreme right; Lake Angeline Company's new shaft on the left. The ore lies in a fold of diorite which outcrops north and south of the arms of the lake.]

BOILER, ENGINE, AND SHAFT-HOUSE—HAMILTON ORE COMPANY'S NO. 2 SHAFT.



HOISTING ENGINE OF HAMILTON ORE COMPANY'S NO. 2 SHAFT.

HAMILTON ORE COMPANY'S NO. 2 SHAFT HOUSE.

[Looking east. Water discharging from bottom of baler.]

depressions in the Huronian rocks, and now found near the caps of hills, are isolated patches of Silurian limestone, which once overlaid the ore-bearing Huronian rocks. Glacial action cut great valleys and gullies in this limestone, leaving caps of it upon the tops of the hills. North and south of the dolomitic limestone, which has a width of approximately 1700 feet, ore-deposits have been found, the ore lying north having quartzite as an overlying rock, while the ore to the south of it has a group of slates locally known as the Hanbury group, which have a thickness of probably 1000 feet : in these two horizons ore is looked for, and many very valuable properties have here been discovered. The foregoing outline serves to briefly describe the conditions east of the Menominee river. West of it the ore occurs mainly in a horizon of jasper-schists, which are locally associated with graphitic slates. Bended, twisted, and folded, the strata enclosing the ore occur with varying pitches and dips. At the extreme eastern end of the range the dip is to the south, which appears to be the normal dip of the district ; while at Iron Mountain the folds cause the ore to stand with a pitch to the north.

The mine of greatest interest from its age and output is located at the above turn and is known as the Chapin. It was discovered in 1879 and has made a phenomenal record for output. In 1880 it shipped 34,556 long tons, reached its maximum of 742,843 tons in 1890, and has shipped to the beginning of 1893 a total of 4,367,344 tons. The surface plant of this mine is one of the most complete to be found in the iron districts ; the machinery is mainly driven by compressed air, which is carried a distance of three miles through a 24-inch iron pipe. Quennesec Falls of the Menominee river furnish, under a head of 52 feet, water to supply three 48 inch and one 54-inch turbines ; these latter operate air compressors, which furnish the air at 60 pounds per square inch for over 100 power drills, and all the hoisting machinery. Boiler power is also available in case of accident or repair being called for by the water-power plant. Ore has been found in four large lenses, but operations are practically confined to what is known as the Chapin or main lens. It is attacked through four shafts, ranging from 350 to 700 feet in depth. The fourth shaft was sunk by the Poetsch freezing method through 90 feet of quicksand. This was accomplished by driving a circle 30 feet in diameter of iron pipes, which were connected to a refrigerating machine ; this reduced the temperature of the ground surrounding the pipes to about zero, freezing it and enabling miners to drill, pick, and blast it like solid ground. An immense Cornish lift pump has been built for this mine, which operates its rods in this shaft. This pump was designed to handle 3000 gallons of water from a depth of 1500 feet vertically. It is the largest mine pump in the iron dis-

BARNUM MINE AND STOCKPILES; OPERATED BY THE CLEVELAND CLIFFS COMPANY.

trict. The ore is broken by power drills and dynamite (containing from 27 to 45 per cent. nitroglycerin), and is loaded on mine cars which are automatically trammed to a shaft, hoisted to the surface, there taken by a railroad car through a pocket with gates, or out over a trestle to the stock pile from which the ore is afterward loaded on railroad cars by means of a steam shovel. By this means a car holding 20 to 22 tons has been loaded in four minutes.

As showing the faith of iron men in the continuity of ore deposits in depth, the Hamilton Ore Co., through its agent, John T. Jones, began diamond drilling north of the Chapin line, and found ore at a depth of over 700 feet from the surface. This ore was identical in every respect with that found in the Chapin, and subsequent development has proved that the great Chapin lens extends by its dip and westward pitch into the adjoining land, north and west. A shaft was sunk in the extreme southwest corner of the land acquired by the Hamilton Ore Co. to a depth of nearly 700 feet before ore was found. The shaft then remained for some time in ore as it deepened and finally passed into the underlying footwall of jasper.

The main shaft has reached a depth of 1325 feet vertically from the surface, while a winze has been sunk over 130 feet additional; making the total depth from the surface over 1450 feet. A second shaft was started after exploiting the ground through the original shaft. This shaft had reached a depth of nearly 1400 feet from the surface when the drillers encountered a seam of water, which drove them out and finally filled the shaft. At a depth of 1325 feet a cross cut to reach the old mine had been started.

Shortly after, the mine adjoining on the west, the Ludington, became flooded by an influx of water from the hanging wall, which was so powerful as to drown the mine-pumps, and many of the men had a close call in escaping the deluge. The water rose with great rapidity and finally reached a level which communicated through No. 1 shaft of the Hamilton mine with the underground workings of that mine. The water poured over into this shaft in torrents and filled the lower workings of the mine. After standing idle for over a year, and the control of the Ludington mine having passed into the hands of the Hamilton Ore Co., plans were completed whereby the mines were to be unwatered. Large balers capable of containing eleven tons of water were made, and the large engines, which had been designed to hoist ten long tons of iron ore, were put into use; in fact, all the hoisting appliances of both mines were temporarily pressed into the service of raising water. The engines used at the No. 2 shaft of the Hamilton mine are the largest ever built for hoisting in the iron districts, and a few figures concerning them and their performance may be of interest. They are of the first-motion Corliss type, with cylinders 32 inches bore by 72 inches stroke, coupled with cranks at right angles, and are fitted with two winding reels, each capable of carrying 2500 feet of 8-inch by ⅞-inch flat wire rope (the largest flat rope ever made or used in this country, and intended to carry a load of ten long tons of iron-ore in addition to the weight of the skip, from the maximum depth of the shaft). The reverse-motion friction clutches are all operated by hydraulic cylinders. The plant weighs 165 tons and hoists its load at a speed of 2000 feet per minute. A test of the engines and boiler plant (six, return flue, tubular style) was made in April, 1892, with the following creditable result:

Length of test	5 hours
Average height hoisted	1,146 feet
Buckets of water hoisted	179
Pounds of water hoisted	3,978,722
Foot pounds of work	4,559,615,412
Amount of water evaporated	95,472 pounds
Total indicated horse power	587
Pounds of water per H. P. per hour	30.6
Foot pounds per 100 lbs. fuel	69,058,762

The balers are run in balance, and 2500 gallons per minute have been raised from a depth of 1325 feet, with a consumption of 26,520 pounds of coal in 24 hours. It would have been out of the question to attempt to unwater the mine with pumps, and it could not have been done in any other way in such a short time, six weeks proving to be the time required. When water was lowered to the 1325-foot level in No. 2 shaft, the miners continued the cross-cut into the old workings and before the water contained had been removed; the object being to tap that body of water and allow it to flow into No. 2 shaft and be raised by the large balers. Diamond-drill holes were kept ahead of the face of the cross-cut, so as to insure the safety of the miners, until one day one of the holes, in line with the cross-cut, tapped the old workings, and air, compressed and hissing, notified the miners that it was time to prepare the final charges to break down the bulkhead of rock separating them from the old mine. The presence of air is accounted for by reason of the water flowing in from the Ludington mine, down the No. 1 shaft of the Hamilton, forcing it ahead up to the ends of the drifts and levels:

HAMILTON AND LUDINGTON MINES. PUMP REPORT.—JULY 9, 1893.

	Total hours hoisting to date.	Total No. of Gallons to date.
Hamilton No. 2 Shaft, large hoist	413	47,286,400
Hamilton No. 2 Shaft, small hoist	327	10,665,600
Ludington "A" Shaft	139	4,687,411
Ludington "B" Shaft	276	10,832,875
Ludington No. 5 Shaft	16½	676,568
Cornish Pump	244	4,482,000
Total	——	78,630,854

Water lowered 891 feet.

R. H. FLAHERTY, Superintendent.

The suddenness of inflow of water and the work subsequently undertaken to unwater the mines show the value of mines maintaining a complete and "up-to-date" map of the underground workings. With such maps work is intelligently and accurately planned, and the cost of making and maintaining them saved a hundred fold in the driving of accurately planned draining drifts. In this case the new cross-cut from No. 2 shaft met the face of an old "room," exactly as planned,—the drill holes being made as a precautionary measure, and in case there was an error in the mine-maps.

West of Iron Mountain and crossing the border of the State line, into Wisconsin, there are two large properties whose ore is of a non-bessemer (or non steel-making) nature, but whose output, since their discovery in 1880 up to the end of 1892, has been over a million tons. Reference is made to the Florence and Commonwealth mines. But to give a description of individual properties would involve too detailed a statement and be, in a great measure, a repetition.

Since its early opening and development in 1878, when four mines sent to market by way of the lake port, Escanaba, 78,028 long tons of ore, up to the end of 1892, this range has sent away 16,779,261 long tons.

THE HISTORY OF STRIKES IN AMERICA—I.

By Arthur A. Freeman.

THE belief still persists in the minds of many that, whatever may be the case in the old world, this country at least would be tolerably free from industrial conflicts and acute crises in the world of employer and employed, if it were not for the pernicious and wicked activity of labor agitators. Such a view, however, does not find support in reason or experience. It is irrational to ascribe the existence of labor troubles in this country to any individual agency. No one cause is adequate as an explanation of the rise and development of the labor movement. There have been many influences and agencies at work, and the only way to trace them and arrive at the correct view of the subject as a whole is to consult the records and employ the historical method. A review of the history of strikes in this country will enable us to determine whether or not labor disturbances are novel in our industrial history and merely the fruit of the new great labor organizations. Everybody is aware that strikes, lockouts, and violent collisions have been frequent since 1877; but not many are conversant with the history of the labor movement prior to that date.

In the early days shipbuilding was the most important industry of the colonists, and this necessitated the bringing over of a large number of skilled craftsmen from England. The shipworkers came mostly from Kent, where organizations of labor existed at that time, and naturally maintained the rules which governed their craft at home. They were strong and vigorous men, and their hours of labor were from sun to sun. Shortly after the close of the first century and a half of the history of the colonies, the wage question began to be discussed. The labor associations of that time were mostly of a purely social character, however, with benevolent features.

The earliest example of the strike known in this country, is undoubtedly the baker's "conspiracy" of 1741. Some journeymen bakers of New York city conspired to refuse to bake bread till their wages were raised. The records of New York criminal proceedings show that an information was preferred against the conspirators for combining not to bake except on certain terms, and that they were duly tried and convicted on this charge. No sentence appears to have been passed, however; probably some technical point prevented the infliction of the punishment. Our notions of criminal conspiracy are not much clearer to-day than they were in 1741, though none of our courts would enunciate the bold proposition that it is criminal to conspire to raise wages.

In 1777 the town of Newburyport, Mass., passed a vote to establish a maximum rate of wages pursuant to an act of the General Court "to prevent monopoly and oppression." The maximum for carpenters was 5 shillings 4 pence a day; for caulkers, 6 shillings; for joiners, 4; for masons, 6. More than this the masters were prohibited from paying; less than this they were allowed to pay.

For the next recorded strike we must refer to a much later date. An association of journeymen shoemakers was organized in Philadelphia in 1792, and in 1796 a "turnout" was ordered by this organization for an increase of wages. The strike was successful, too. In 1798 the same body again struck for an increase of wages, and again scored a victory. In 1799, we find this organization again up in arms; this time to resist a reduction. The strike lasted ten weeks, and was a partial success. The association numbered over one hundred members.

In 1803 the notorious "Sailors' Strike" occurred in New York city. A number of sailors demanded an increase in wages. To obtain it, they formed in a body, marched around the city, and compelled those seamen who remained at work to leave their ships and join the strikers. Constables arrested the leader and dispersed the strikers, causing the collapse of the strike. It is rather remarkable to find the strikers of 1803 employing such modern methods as street parades and coercion of the "scabs."

In 1805 our Philadelphia journeymen shoemakers' union is again in evidence. Another strike is ordered for an increase of wages, which, after several weeks, fails. This strike is historical, for a remarkable conspiracy trial grew out of it. Eight men were tried on an indictment containing three counts. The first count charged that the defendants had contrived "unjustly and offensively" to increase the market price for their services, to the damage and prejudice not only of the masters, but of other journeymen (!), the citizens generally, and the dignity of the State. The second count referred to the agreement to prevent other workmen, by *threats and other unlawful means*, from continuing to work on the old terms; while the third count recited that they had unlawfully met and tried to form themselves into a club and ordain "arbitrary and unlawful" by-laws for their own guidance as well as for the government of other workmen. These "arbitrary" by-laws were simply the agreement not to work for the old rates. Much testimony was taken at the trial, one master alleging great annual losses through inability to fulfill his contracts consequent upon the refusal of the union to allow its members to work with non-members. It was also brought out that the union men had used threats and violence to secure the coöperation of refractory workmen, and that the system of boycotting was in full operation.

Very remarkable indeed is the charge of the recorder, and especially curious are his politico-economic propositions. The usual means, said the recorder, by which the prices of work are regulated, are the demand for the article and the excellence of its fabric, and to make an arbitrary and artificial regulation without regard to the excellence of the work or the demand for it, is an unnatural way of raising the price of labor. Such an unnatural way exposes commerce to ruin and is therefore against the public welfare. The recorder went on to condemn boycotting and all forms of indirect coercion. A combination of workmen, he said, to raise wages, may be considered in a twofold point of view: one is to benefit themselves, the other is to injure outsiders. The rule of law condemns both. A combination may not attempt to raise wages in ways perfectly allowable to individuals.

The jury found the defendants "guilty of a combination to raise their wages," and they were each fined $8 with costs.

In 1806 the tailors organized a trade-union. Prior to that date members of that craft coming from England continued their membership in the tailors' unions of the old country. The same is true of the hatters, who organized their first union here in 1819.

In 1809 the New York journeymen cordwainers' association ordered a general strike against all the masters. A strike in one of the shops had been defeated by the proprietor taking his work privately to other shops. In the general strike about 200 men were involved. In this strike the term "scab" first became current. A conspiracy trial followed, and a verdict of guilty secured. The defendants were fined only $1 with costs each. The indictment in this trial was almost a copy of that upon which the Philadelphia shoemakers were tried, but the judge's charge to the jury was very different. The court declared that it was by no means clear that an agreement not to work except for certain wages was in itself illegal, and laid stress on the fact that the offense of the strikers consisted solely in the use of unlawful means to obtain their object. The "unlawful means" were the coercion of non-unionists and the ordering of strikes against masters not directly involved in the quarrel.

The next strike and attendant conspiracy trial occurred in 1815. Pittsburgh was the scene and the journeymen cordwainers were the strikers and defendants. The indictment presents nothing new, but the judge's charge again marks an advance in opinion on the subject of conspiracy. The political economy of the Philadelphia recorder is gently brushed aside, the court laying down the proposition that the jury has nothing whatever to do with the question of regulating prices, wages, or profits. "It has been truly said," held the court, "that every man has a right to affix what price he pleases on his labor. It is not for demanding high prices that these men are indicted, but for employing unlawful means." Here, too, the "unlawful means" referred to are boycotting and coercion of outsiders. The court's distinction between legitimate and illegitimate boycotting is still followed in our courts. "You have a right," said the court, "to have your boots, coat, or hat made by whom you please. You may advise your neighbor not to employ a particular mechanic. But should you confederate with others to ruin any particular shoemaker, tailor, or hatter, by preventing persons from employing him, this would be unlawful." The strikers were convicted.

In 1821 the first printers' strike occured. It was ordered by an Albany typographical union because of the employment of a "rat" in one of the offices.

In 1822 it was the turn of the New York journeymen hatters to strike and be tried and convicted for conspiracy. But greater interest attaches to the strike and conspiracy trial of 1827. Some Philadelphia tailors struck to secure the reinstatement of five journeymen who had been dismissed for demanding higher pay for a particular job. New employés were followed in the streets, threatened, and induced to quit work, while workmen in other shops were induced to refuse to work as long as their employers continued to receive work from the shops concerned in the strike. The judge in this case dwelt on the use of illegal means, but the jury found the defendants guilty only on one count,—that charging conspiracy to compel masters to re-employ discharged workmen.

During the years 1825-1830 the ship-carpenters and caulkers in

New York city and along the Atlantic coast were agitating the ten-hour day question, and small strikes in those trades were of frequent occurrence, sometimes succeeding and sometimes failing. It is remarkable that some of the employers looked with favor on the ten-hour day, and expressed willingness to pay the men by the hour and allow them to make ten hours their limit. In 1832, however, a meeting called by the master mechanics to consider the expediency of adopting the ten-hour plan passed resolutions against the proposal. The merchants and ship owners of Boston, then the center of the agitation, had become so weary of strikes and disputes that they held a meeting and passed resolutions declaring that they will employ no journeyman belonging to any labor association nor give work to any master mechanic or contractor employing such journeymen. The merchants might have been indicted for conspiracy, had the workmen traced the ruin of any particular contractor to the agreement of the merchants; but there is no record of any attempt to indict the merchants.

In the same year several hundred workmen in New Bedford struck for the purpose of regulating the hours of labor ; they held meetings and employed the town-crier to announce them.

In 1833 several strikes occurred, two of which led to conspiracy trials. One of these is the strike of the Thompsonville, Conn., carpet factory employés for an increase of wages. Suit was brought against the strikers for conspiring to raise the "price of wages" and hindering other weavers from going into the employ of the plaintiff. The great point in the case was whether "peaceably conspiring" or arguing with the workmen to refuse to work for less than a named sum, constituted a ground for civil action on the part of the employer. The case consumed a week. The court charged the jury in the negative, and the verdict was for the defendants.

The other case is that of the Geneva, N. Y., journeymen shoemakers who struck in a body against the refusal of the employers to dismiss one of the men who failed to live up to the rules of the union. The strike was successful, but the strikers were indicted and tried for conspiracy. The indictment charged the strikers with having formed themselves into an unlawful club and conspired to prevent journeymen from working below certain rates prescribed by them, and with having agreed, in pursuance of the general conspiracy, not to work for any master who should employ the journeyman obnoxious to them, although he was a good and free citizen and faithful workman. The court gave judgment in favor of the strikers, on the ground that the indictment did not specify an offense known to the laws of the State. But the district attorney sued out a writ of error, and the case was carried up to the supreme court, which reversed the judgment of the lower court, holding that the conspiracy was indictable because it was an act *injurious to trade*. It is important to the best interest of society, reasoned the court, that the price of labor be left to regulate itself, or rather be limited to the demand for it. Combinations to enhance or reduce the natural price are injurious. If the bootmakers may say that boots shall not be made for less than $1 per pair, it is optional with them to say that $10 or $50 shall be the price, and the result would be an odious monopoly and an enormous tax upon the community. Still if any man thinks the fixed price too low, he may refuse to work for it; what he has no right to say is that no other workman shall accept it.

In 1834 the female shoebinders of Lynn, Mass., struck for an increase of wages, and failed. They refused to take work to their homes, but the employers found no difficulty in getting the women of neighboring towns to take it. In the same year the Lowell female factory operatives struck on account of a reduction of wages. Other strikes occurred, but the most important strike of the year was that of the laborers employed at Mansfield, Mass., upon the construction of the Providence railroad. The strike resulted in a riot, which had to be suppressed by a company of militia. For the first time we here find the militia playing a part in the struggle between labor and capital.

In 1835 fifteen strikes occurred in different parts of the country. The stone cutters of New York and other cities succeeded in securing a ten-hour work day, and workmen in Philadelphia coal-yards, who also desired the ten-hour system, succeeded in obtaining assent to the proposition that "they work from sunrise to sunset, with an intermission of three hours, these to be designated by the workmen." Other Philadelphia workmen succeeded in establishing the ten-hour system, a certain firm taking occasion to say that it was their "candid impression that if a man works ten hours a day, it is all-sufficient." The city council also resolved that the hours of labor for city employés shall be from 6 to 6, allowing one hour for breakfast and one for dinner. The city also raised the wages of certain of its employés. Working-women of Philadelphia having met to form a new scale of prices, the master bookbinders "considered the cause of female laborers as one whose claims were founded on justice," and deprecating the course of greedy and unscrupulous employers, resolved "that $3 per week is the least amount of wages those possessed of the principles of humanity could offer."

In 1836 seven strikes occurred. The most serious were the strikes of the longshoremen, riggers and others connected with shipping in New York and Philadelphia. The strikers demanded a reduction of hours and an increase of wages, and threatened the new men employed. The affair was settled by the military. Equally important was the New York tailors' strike for an increase of wages. By threats they kept others from working except at union rates. Several hundred of them paraded the streets with music and banners. Twenty-one of them were tried for conspiracy, convicted, and sentenced to pay fines ranging from $100 to $150. The judge in this case followed the decision of the supreme court in the case of the Geneva shoemakers just referred to. In his charge, he impressed on the minds of the jury that the case was not to be considered "a mere struggle between master and journeyman." It was one on which the harmony of the whole community depended. "Let these societies only arise from time to time, and they will at last extend to every trade in the city, and there will be as many governments as there are societies." The judge declared that there was "no necessity for such societies. Combinations were not necessary in this country for the protection of mechanics or any other class. They were of foreign origin, not in harmony with our institutions or national character, and they were mainly upheld by foreigners."

The year 1837 had two strikes. The employés of a Rochester N. Y., contractor struck for an increase of wages. The Rochester *Democrat*, saying that "there is a settled determination among the laborers neither to comply with the terms of the contractors themselves nor to allow others to do so," adds that the workmen "cannot be censured for refusing to work fifteen hours for six shillings." In Boston, sailors struck for an advance from $14 to $16 per month. The demand was refused on the ground of commercial depression. Street processions and rioting followed. Within a week the strike failed.

In 1838 there was a strike of factory girls at Dover, N. H., against a proposed cut-down. The girls placarded the fences and office-doors with rhymes abusing the employers and overseers.

There is no record of the result. In 1839 there were two strikes of railroad laborers. One was on the Eastern railroad, near Salem, Mass., the demand being a shorter work-day. The other strike was on the sections between Reading and Hamburg, Pa., for an increase from $1 to $1.12½ per day, and, in some cases, for more whiskey, the allowance being 1½ pints per day for each man, dealt out in nine doses. The wages were increased on one section, but to the appeal for more whiskey the contractors turned a deaf ear. In 1840 railroad laborers in Rawley, Mass., struck in consequence of certain workmen having suffered deductions of pay for failing to begin work at the required hour. New men were prevented from working, an overseer was attacked, and attempts were made to destroy property. But the rioters were dispersed, the ringleaders arrested, and work was resumed as usual.

The year 1842 is remarkable for the first appearance of the iron industry on the scene of strikes. In February boilers in the rolling mills at Pittsburgh struck against a reduction of wages to $5 per ton. In July the strikers resumed work at the reduced rate, which prevailed until 1845. In the same year a serious strike of Philadelphia weavers occurred on a question of wages. The strikers who desired to return were intimidated, and many violent attacks were made on the mills, resulting in destruction of looms and chains. The riotous proceedings continued into January, 1843, when the difficulties were amicably adjusted.

In 1843 there were strikes of female operatives in Philadelphia and Chicopee, Mass. An important strike was that of the West Philadelphia bricklayers for higher wages. There were parades, attacks on fire companies, and destruction of property. The mayor and sheriff refused to interfere because the county had not paid the last posse called out. There were other minor strikes. In 1844 Philadelphia had three strikes for higher wages; no other strikes are recorded. In 1845 the boilers in the rolling mills of Pittsburg struck and received an advance of $1 per ton. The price of boiling remained at $6 per ton until 1850. There were four other strikes, three of them successful. In 1846 only one strike occurred, and it failed.

During 1847 many strikes prevailed, some for shorter hours . nd some for higher wages; some of them were successful. The high price of provisions was a fruitful source of strikes; flour went up to $14 per barrel in the early part of the year. The ship builders of Bath made an effort to break down the ten-hour system. When the short days of the winter had passed, the employers demanded the old system of working from sun to sun, and for some weeks the industry was at a standstill. But public opinion was on the side of the workmen, and the employers were finally forced to yield.

In 1848 the strikes were few in number but very violent. The Fall River weavers struck against a reduction. The mills were closed three weeks. There was considerable rioting, and some of the strikers were sent to prison for disturbing the peace. The strike failed. The coal miners on the Monongahela river struck against a reduction, and made violent demonstrations. A number of mills shut down, and others reduced wages. Seven cotton factories of Allegheny City shut down in consequence of a dispute with the men, and 2000 operatives were thrown out of work. There was furious rioting and attacks on the mills. A number of rioters were arrested, tried, and found guilty. Finally the factories resumed on the ten-hour plan with a reduction of 16 per cent. in wages.

In 1849 there was only one strike at a cotton mill, and it failed. In 1850 business was dull throughout the country. Out of 2,485,-700 spindles in New England over 800,000 are said to have been stopped. The Fall River mills gave notice of a reduction of wages, and a strike of great magnitude followed causing widespread suffering. Arbitration was suggested by a workman, but the suggestion received no attention. During nearly six months 1300 persons were idle. Finally the reduced rates were accepted. The Pittsburgh iron workers also struck against a proposed reduction, but the mills started with imported workmen. There were serious disturbances and an attack on one of the mills. Arrests were made and many men and women were sentenced to imprisonment and fines. The strikers were subsequently pardoned by the governor on petition of part of the jury and a large number of citizens. During the years 1850 and 1851 strikes for the ten-hour system occurred in many industries, but most of them failed, owing to the increasing immigration of foreign workmen.

In 1852, besides a number of minor strikes, there was a remarkable strike at the Salisbury, Mass., mills. The employés, members of the oldest families in town, had for thirty years enjoyed the privilege of fifteen minutes during each half day for luncheon. Owing to the abuse of this privilege it was suddenly abolished. A hundred employés disregarded the order and were dismissed; the female weavers thereupon went out on a "sympathetic" strike The whole town debated the question. The strike was joined by the employés of the Amesbury mills, where the luncheon privilege had also been suddenly abolished. At length the mills were started with Irish help, and the former operatives gradually left the places. The town suffered greatly from the crippling of its chief industry and the depreciation of property.

There were twelve strikes in 1853 ; most of them failed. In some cases shorter hours were granted. In 1854 ten strikes occurred, the most notable of which was the strike of the compositors of the Philadelphia *Register*, who objected to the employment of girls in the jobbing department. Some of the strikers were arrested and charged with conspiracy to prevent the issue of the paper. Only three strikes occurred in 1855, one of them,—that of the cigarmakers at Suffield, Conn.,—lasting seven weeks. The strikers were financially supported by the cigarmakers of other cities. In 1856 Irish laborers upon the wharves in Boston struck against the introduction of the steam-hoisting machine, and were of course defeated. In 1857 there was a strike of five months' duration of glass blowers in Philadelphia. Owing to the hard times and the then universal truck system, workmen at other points were unable to send money to the strikers, but wagon loads of provisions were sent from the truck stores. Two other strikes occurred in that year. In 1858 the iron workers organized their first union, "United Sons of Vulcan." There were four minor strikes and one strike of some importance. The female weavers and other employés at Chicopee, Mass., resisted a reduction. There was more or less rioting, which was suppressed by the police. Finally the reduction was accepted.

Nine strikes occurred in 1859, some of them of a serious character. The hatters' union ordered a strike against a dealer in Boston for refusing to observe its regulations in respect to the employment of apprentices and "scabs." The dealer held out three years, and then acceded to the demand of the union. The coal miners along the Monongahela valley and in certain counties in Pennsylvania struck against the irregular sizes of the cars. The strikers demanded that scales should be erected at the mouth of the pit to weigh each man's coal. Speakers were engaged, and the whole region was interested in the struggle. After a few months the strike collapsed on account of the poverty of the miners. Twenty-seven persons, men and women, were arrested and charged with riotous conduct, the women having stood at the entrances of the pit making the miners take oath that they would not "blackleg" or work while part were on strike. Those arrested were tried and convicted, but the jury recommended them to mercy, and the judge only imposed fines of from $5 to $10 and costs. The year also witnessed a struggle between the glass-blowers and the manufacturers. An eventful meeting of the glass-blowers having been held, the manufacturers determined to break down the union and took in apprentices with the intention of throwing a large number of employed upon the union for support. The glass-blowers met this move by a resolution limiting the number of apprentices to two in a factory. A general strike ensued, and non-union men were imported by some manufacturers. Fourteen strikers were arrested for conspiracy. The strike failed, and the union fell with it and did not revive until 1865.

We have reached the end of the first epoch of the labor movement. The facts set forth warrant certain general conclusions to which attention should be drawn. We observe that during the first epoch,—that is, up till the war of the rebellion,—there were very few strikes against reductions of wages. The great majority were for shorter hours and increased pay; and this is a sure indication of general national prosperity. Labor manifestly felt strong, and any grievance seemed sufficient cause for a strike. No great organizations existed; the trades unions were small and weak; but labor felt that the country was new, rich, and undeveloped. The natural opportunities were open to all; land was practically free, and there was no pressing necessity for accepting low wages when an independent subsistence on the soil presented itself as a practicable alternative. The population was relatively small, while the natural resources were abundant and the avenues for enterprise almost innumerable. Money wages were lower, but so was the standard of living, while the fear of involuntary idleness scarcely existed at all. In fact, during the epoch under consideration we do not encounter any "problem of the unemployed," the chief reason doubtless being that the unoccupied public lands were ready to receive any portion of the army of industry for which there was no immediate need. The laborer felt secure and independent. It was natural for him to seek to improve his condition under such circumstances, and his strikes were demands for better terms, not protests against any encroachments on the part of employers.

When we come to treat of the second epoch of the labor movement, we shall find a great change in the conditions and a correspondingly great change in the character of the struggle.

THE NEWEST WARSHIPS OF THE UNITED STATES NAVY.

By Lieutenant W. H. Jaques, U. S. N.

NOT many years ago a distinguished citizen of the United States was asked to respond to the toast of "Our Navy." Rising slowly from his seat, he commenced by saying: "If the length of my reply is to be governed by the size of our navy, I have already said too much." Happily that period has passed, and we can point with some pride to the vessels of what so many have termed "Our New Navy." But even this is not enough; we have made but a commencement.

Since our first steel ship was built such progress has been made in the United States alone that already some of our types seem obsolete. This is not unnatural and should not for a moment stop the good work. On the contrary, it should be an encouragement for further development in the sciences of naval architecture and ordnance; for the granting of more opportunities to the minds who have already accomplished so much, and larger appropriations for the employment of native labor and for the spread of the technical education that is so valuable to the nation and its people. The space permitted for a sketch of any one of the important questions of the day covered by the standard magazines allows scarcely a chapter of the volumes that could be added to the debates and treatises already presented showing the necessity for the continuation of the reconstruction of the navy.

We hear the cry on all sides that no one will disturb us,—that even the strongest European powers fear our marvelous resources. These resources will no doubt eventually secure victory, but at what a cost! Meanwhile, increased wealth and consequent luxury, indiscriminate immigration, chronic dissensions in the South American and isthmian States, exclusion laws, and other causes are surely leading us into the midst of dangers that require the insurance of naval preparation, which should be all the more easy to secure, bringing as it will employment for native labor at a period when a labor crisis is imminent. It is not new to call this preparation an insurance, but I fear very few of either our legislators or our tax-payers realize how low a rate of taxation it requires. It is not one-fourth of what we pay for the insurance on our homes or our lives, and yet the losses of life and property that a war, resulting from an absence of adequate insurance of this character, would cause are almost incalculable.

Following the lead of dating everything from this Columbian Exposition year, I shall attempt a description of our navy of 1893, taking advantage of prolific photography and transferography (if I may be allowed to coin a word) to present a more agreeable accompaniment to my tabulated history than dry technical phrases. Of those who advocate but one type of warship, the cruiser, I would ask, would you reform the army by abolishing everything but the cavalry? Heavy artillery and coast fortifications alone cannot protect the country any more than battle-ships. Just as the various lines and types of arms are requisite for the most efficient army, so are a variety of ships needed in the navy, if our personnel are to be victors in the struggles that will surely come for the vast wealth we are accumulating in the United States.

The growth of our commerce on the lakes* and the need of shorter water-routes must be firmly kept in mind. If a treaty prevents our actually placing on the lakes a warship more powerful than the unique *Michigan*, it cannot prevent our making suitable preparations for the care of our rapidly increasing wealth on these most important water-courses. Many of our readers will surely see the water-ways connecting the great lakes with the sea and the Nicaragua canal filled with ships bearing our flag and having the support of our army and navy; and these will then become the natural, although artificial, boundaries of the United States. We have made a feint in this direction by placing upon the lakes, perhaps in violation of the treaties, the brick battle-ship *Illinois*, quite as unique and harmless in another direction as our present paddle representative, but much more instructive to the people and an object lesson that must bring its benefits to the service it represents and to our legislators in their periodical struggles for appropriations.

The decision of the Navy Department to cover its exhibits in a "brick" ship was excellent. Hundreds of thousands of citizens and tax-payers of the United States have had an opportunity to learn what a battle-ship is, why she costs so much, what she contains, and what her purpose is; but it is to be regretted that sufficiently large appropriations were not made to enable the Depart-

*See THE ENGINEERING MAGAZINE, September, 1893.

ment to send a full crew of officers and men to still further interest and educate visitors to the World's Fair by having attractive drills and exercises.

Mr. Horace See, America's eminent naval architect and marine engineer, in THE ENGINEERING MAGAZINE for July, 1891, described the inauguration of our new steel navy by Secretary (now Senator) Chandler and reviewed the progress made up to the date of his article. The *Atlanta* was the first of our steel cruisers to be put in commission, and it has been in continuous service for eight years. The *Chicago* and *Boston* have also shown the excellence of their

THE COLUMBUS CARAVEL, "SANTA MARIA."

construction, the value of their types, and their general efficiency by an almost continuous service of from five to seven years, while the *Dolphin*, commissioned in 1885, has been around the world without developing that structural weakness the fear of which caused so much anxiety. She is now continuing the valuable diplomatic work in which she has been so actively engaged.

Without reviewing the history and qualities of the vessels by name, I have pictured them as far as possible in sequence of their christening, omitting duplicates of types, except in a few cases, and will call attention to the special elements of construction which re-

DOUBLE-TURRETTED MONITOR, "MIANTONOMAH."

quire more prominent consideration. In presenting a series of illustrations for a suitable comparison and description of the ships of our navy, it is to be regretted that they could not all pass in review before the same camera and focus, or be reduced to the same scale. The naval architect and engineer, however, who are most interested in such comparison, are familiar with the general de-

UNITED STATES DESPATCH-BOAT "DOLPHIN."
[Photograph Copyrighted, 1893, by J. S. Johnston.]

tails of our modern ships ; and the annexed table will give to others all the information for correct comparison.

Our battle-ships must not be condemned because battle-ships of other nations have proved unmanageable or weak. They are of much less tonnage than the heaviest of the British and Italian navies. The former has seven ships of 14,150 tons displacement and one of 14,260 tons, carrying 67-ton guns ; the latter two ships of 15,900 tons, carrying heavier guns of less ballistic power ; while the *Indiana*, *Massachusetts*, and *Oregon* are 10,231-ton ships and the *Iowa* 11,286 tons, all carrying 57-ton 13-inch B. L. rifles for their heaviest calibers.

UNITED STATES PROTECTED CRUISER "ATLANTA."

In 1887 the British ship *Victoria* was supposed to surpass every other battle-ship ever designed in points of power, protection, speed, and general efficiency. To-day she is at the bottom of the sea, the grave of 360 brave officers and men, victims of a fatal maneuver, and criticised on all sides for her instability and improper distribution of weights.

Save her speed trials under circumstances far from service conditions, we have no data on which to judge her efficiency ; but the good results that have obtained in all our new ships augur well for the armored cruiser *New York*. There has naturally been much dis-

UNITED STATES PROTECTED CRUISER "CHICAGO."

[Photograph Copyrighted, 1893, by J. S. Johnston.]

UNITED STATES DYNAMITE CRUISER "VESUVIUS."

cussion about the details of this splendid cruiser, particularly the reduction of weight and change of form of her armor protection. Without reviving this discussion, which space will not allow, a word about conning towers and ammunition and communication tube protection is most necessary.

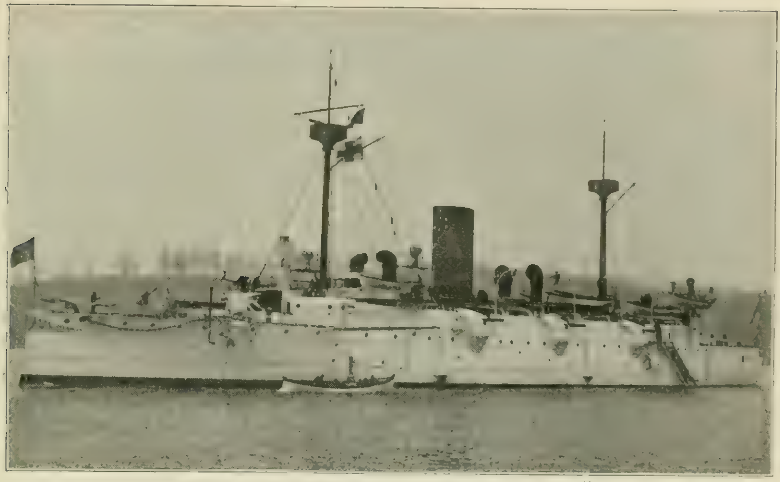
If conning-towers are to be of any service, and if commanding officers are to be expected to remain in them during an engagement, they must be made larger and heavier ; and marked attention must be paid to the fitting and use of thick hollow forged tubes for communication and ammunition service. This is even more important, if possible, in cruisers than in battle ships and other heavily armored ships, where the thickness of the side, diagonal, barbette, and turret armor afford additional protection. If a 12-inch or a 13-inch projectile should strike any of the conning-towers as at present designed they would probably serve as an escort to the projectile for the remainder of its range, and their inmates would take an involuntary "Trip to Mars."

There was a time when the designs of our ships had to be modified to meet the conditions of domestic supply, but that period has passed, and I am happy to state that our steel-makers can now make anything that the most ambitious naval constructor can handle or the ordnance engineer desire. The *New York* is accepted by the United States authorities as the most advanced type of a protected cruiser, and this acceptance has been more or less endorsed by recognized authorities all over the world, especially by the commanding officers of the British cruiser *Blake*, from whose general design the *New York* was laid down.

In 1890 the protected cruiser *Blake* was held to have no equal, let alone a peer; yet the United States admired and accepted her and did a little better. Splinter bulkheads will probably be abolished before the majority of our readers learn their purpose; instead of the usual splinter protective deck, second armored decks

UNITED STATES GUNBOAT "YORKTOWN."

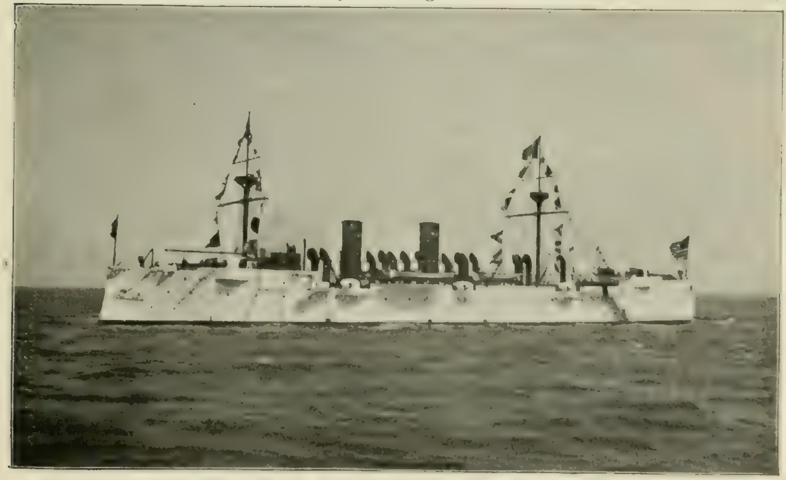
will be provided. These rapid changes are frequently used as arguments for inaction, but they are much less frequent than the returns of hunger that we do not hesitate to satisfy; separated by much greater periods than the seasons for which we provide constantly changing forms and qualities of clothing. But our attention to them is no less important, and the benefits to our industries and people not less useful; as an education, an occupation, a provision for adding to the usefulness and happiness and general benefit of our people; a safeguard and protection against the evils of the wars for which they are designed. Let us hope that these



UNITED STATES PROTECTED CRUISER "CHARLESTON."

splendid engines may not be needed for other than purposes of occupation, education, and discipline; but let the good work go on that we may have some insurance if the fire comes.

The value of the low freeboard coast-defense monitor is still doubted by many, but my own experience in a type much less modern and efficient than those now under construction leads me to accept them as excellent coast-defenders. The work on these monitors has been carried to about 80 per cent. of that necessary to complete them; another year ought to see them in commission.



UNITED STATES PROTECTED CRUISER "BALTIMORE."

The delivery of 900 tons of heavy armor in one month from the shops of the Bethlehem Iron Company ought to put a stop to the chronic cry that the rapid completion of our remaining unfinished ships is choked for want of armor. This excuse has been as freely used as the once dreaded medical diagnosis *malaria*, which fortunately has ceased to be a fad.

The principal delay in the delivery of armor has been due to the Navy Department's desire for experimentation to decide the best type of steel armor. This has resulted in a most natural expenditure of time, as well as in greatly increasing the cost of the already expensive plants laid down by the manufacturers. Then, too, the demand for cruising vessels has caused the armor for the coast-defense monitors to be put aside to secure the more rapid delivery of that for the armored cruisers and battle-ships of later designs.

If a decision is reached defining the kind, shape, dimensions, and ballistic tests of the armor, and no alterations are asked after the proposals are issued, and the order for the armor is placed when the contracts for the ships are awarded, there ought to be no delay in their completion for want of armor.

The title "The U. S. Torpedo Boat *Vesuvius*," given to this novel craft in Mr. See's paper,* bids fair to define her future service as a torpedo gunboat, since the many years of experiment

* THE ENGINEERING MAGAZINE, Vol. I., p. 434.

UNITED STATES GUNBOAT "PETREL."

UNITED STATES PROTECTED CRUISER "PHILADELPHIA."

[Photograph Copyrighted, 1893, by J. S. Johnston.]

UNITED STATES PROTECTED CRUISER "SAN FRANCISCO."
[Photograph Copyrighted, 1893, by J. S. Johnston.]

with her dynamite guns have failed to secure confidence in them. Her efficiency as a high-speed gunboat has been proved.

The completion of the harbor-defense ram *Katahdin* is looked forward to with interest as the first of a type designed especially for ramming. Lord Armstrong's recent endorsement of this type will cause it to be looked upon with favor in Great Britain ; but his statement that "the strength and stability of the *Camperdown's* prow ram were insufficient to deliver an effective blow without peril to herself," more strongly endorses my views on, and recommendations for, the substitution of the submarine gun, the projectile of which becomes a *detachable ram* reducing to a minimum the dangers attending ramming with a *fixed ram.*

UNITED STATES TORPEDO-BOAT "CUSHING."

The practice cruiser *Bancroft*, although much too small, is such a marked advance in the right direction that perhaps we ought not to make this criticism. Impressed with the scholastic period of the cadet's life, legislation has wiped out the legendary *Midshipman* and now follows it with miniature ships for *cadets*. She will at least contain much that is modern and we trust is only a forerunner of other vessels, valuable practical adjuncts of a school in which only the best naval education, discipline, and sense of responsibility can be taught.

The reports thus far obtained from the ships that have been commissioned contain few adverse criticisms and describe them as useful, comfortable vessels. Our designers and builders can unite

UNITED STATES PROTECTED CRUISER "CONCORD."
[Photograph Copyrighted, 1893, by J. S. Johnston.]

with the Department in congratulation in the possession of war craft of many useful types combining speed, coal capacity, battery power, protection, and service adaptability. Time alone can show whether they are economical.

I have purposely omitted illustrations of the wooden steam and sailing vessels which are incurring expenses out of proportion to the service performed ; the single-turret monitors that ought to be sorted for sale or transformation into floating batteries, tugs, receiving ships, and the *one* wooden torpedo-boat, the *Stiletto*, which helps to relieve the loneliness of the *Cushing*, our sole steel representative of a type of which we should have hundreds if they are of any

UNITED STATES NAVY—"NEWARK."
[Photograph Copyrighted, 1893, by J. S. Johnston.]

value at all. A running mate to the *Cushing* (the *Ericsson*), is being built on the Mississippi river,—a small and tardy tribute to the accomplishments of a great man.

Although in the British naval maneuvers of 1893 better results were obtained with torpedo craft than formerly, there appears to be little doubt that at their highest speeds even the present types will be so shaken to pieces as to make their lives very short.

UNITED STATES GUNBOAT "BENNINGTON."
[Photograph Copyrighted, 1893, by J. S. Johnston.]

They are extremely frail; something must be done to make them more efficient.

As regards future construction Congress has provided for three gunboats of 1200 tons displacement, for which bids were opened October 17, and the Navy Department has a small fund available for the purchase of a submarine and two third-rate torpedo-boats. These will go but an infinitesimal way toward utilizing the facilities of our many shipbuilding plants, which, by the end of next year, will probably have completed or launched 90 per cent. of the warships that are now in their yards.

The objection to the construction of sheathed gunboats because

LOW FREEBOARD COAST DEFENSE BARBETTE "MONTEREY."

of a technicality in the act appropriating a certain sum for three steel gunboats is another instance of the inadvisability of Congress deciding the type and dimensions of ships. This decision should be left to the Secretary of the Navy, who should be held as responsible for the success of the program he advises as is the British Premier for his political measures.

The struggle to put more in a ship than she can usefully carry still continues, and doubtless the next move will be to individualize ships and design, construct, and fit them for one or more special purposes. While we are all the time increasing the power, variety, and rapidity of fire of our armaments, we seem to have lost sight

BARBETTE ARMORED CRUISER "NEW YORK."

[Photographed while steaming twenty-one miles an hour on her Official Trial Trip.]

of their ammunition supply. This last is the most difficult problem of the period. We shall probably have to resort to ammunition-supply ships in the manner that coaling vessels accompany blockading squadrons. The difficulty of coaling ships even in the best weather and under fair conditions while engaged in maneuvers warns us of the necessity of having abundant and large chutes conveniently placed for the reception of fuel, for it will probably be a long time before even liquid fuel will be generally used and much longer before power is generated from the element in which the ship floats.

In connection with the question of coaling ships, there is the

THE BRITISH CRUISER "BLAKE."

more vital one, the source of coal-supply for our warships. The possession of suitable coaling-stations has been recommended by many administrations, urged by many secretaries, begged for by naval officers, and by citizens whose interests in foreign territory may require protection, but never more forcibly or comprehensively than by Secretary Chandler in 1883, when the number of our coaling-stations, meager as it was, was in excess of that of a later period.

Great Britain has spent enormous sums for the establishment and service of coaling-stations, the Imperial Defense Act of 1888 alone estimating £360,000 ($1,746,000) for coaling stations and £353,851 ($1,716,177) for the erection of barracks thereat.

UNITED STATES GUNBOAT "MACHIAS."

The present year has witnessed prolific inquiry as to our progress in naval architecture and engine-building, and many noted visitors have expressed genuine surprise upon their discovery of our plans, methods of construction, and resources of domestic supply, entitling us once more to a place in the front rank of naval construction. Although largely and wisely based upon foreign experience, this rapid progress must naturally cause anxiety in countries where the capacity of production has already surpassed the demand.

The Bureau chiefs in their reports give in detail the advantages and improvements, the principal among which are: greater speed,

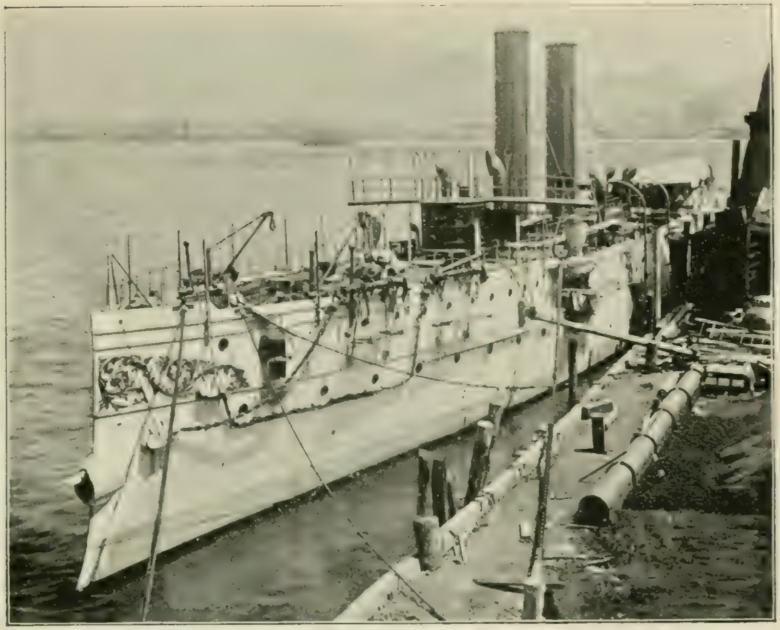
PRACTICE CRUISER "BANCROFT."

[Photograph Copyrighted, 1893, by J. S. Johnston.]

stronger and better boilers, higher working pressures, increased heating surface and the development of mechanical appliances in the direction of the much-to-be-sought-for qualities of endurance, further development of triple screws and independent triple-expansion engines on the same shaft, or disconnecting cylinders to combine economy in ordinary cruising with power for emergencies.

Great advances have been made and many problems have been solved, but many others yet remain to be solved. The comparative values of liquid fuel, compressed petroleum residue, forced

PROTECTED CRUISER "COLUMBIA," SEPTEMBER, 1893.



CRUISER "MARBLEHEAD," SEPTEMBER, 1893.

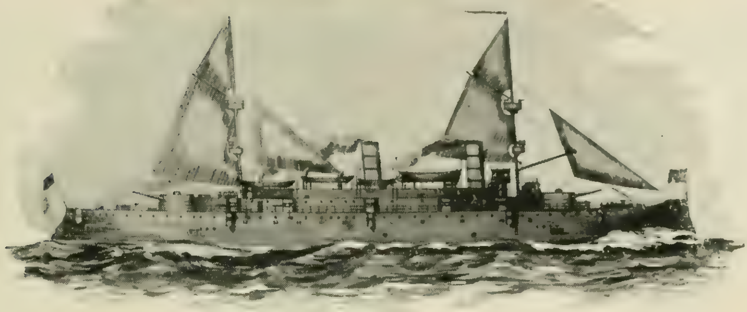
draft and tower smokestacks, triple screws (although fair results with them have been obtained abroad), thick and thin armor protection, long or short, heavy or light, batteries and many other problems are yet surrounded by interrogation points.

Although the latest designed British warships will have but two screws instead of three, indicating the belief of British designers that more efficiency will thereby be obtained, the combination of economy with emergency power already referred to would appear to be most easily obtained by the three-screw propulsion. Further, Professor Elgar says, "The number of propellers is more likely to be increased in the future than diminished."

Longer stroke in the vertical engine and more comfortable working spaces in the engine-rooms can be easily protected by inclined armored towers without any great sacrifice of other weights. In the boiler-room there is much yet to be hoped for, but with the boiler shells forged in one piece (soon to come), and the control of liquid fuel, the stoker's life will be made much more endurable.

It is a question much disputed among naval architects and

HARBOR-DEFENSE RAM "KATAHDIN."



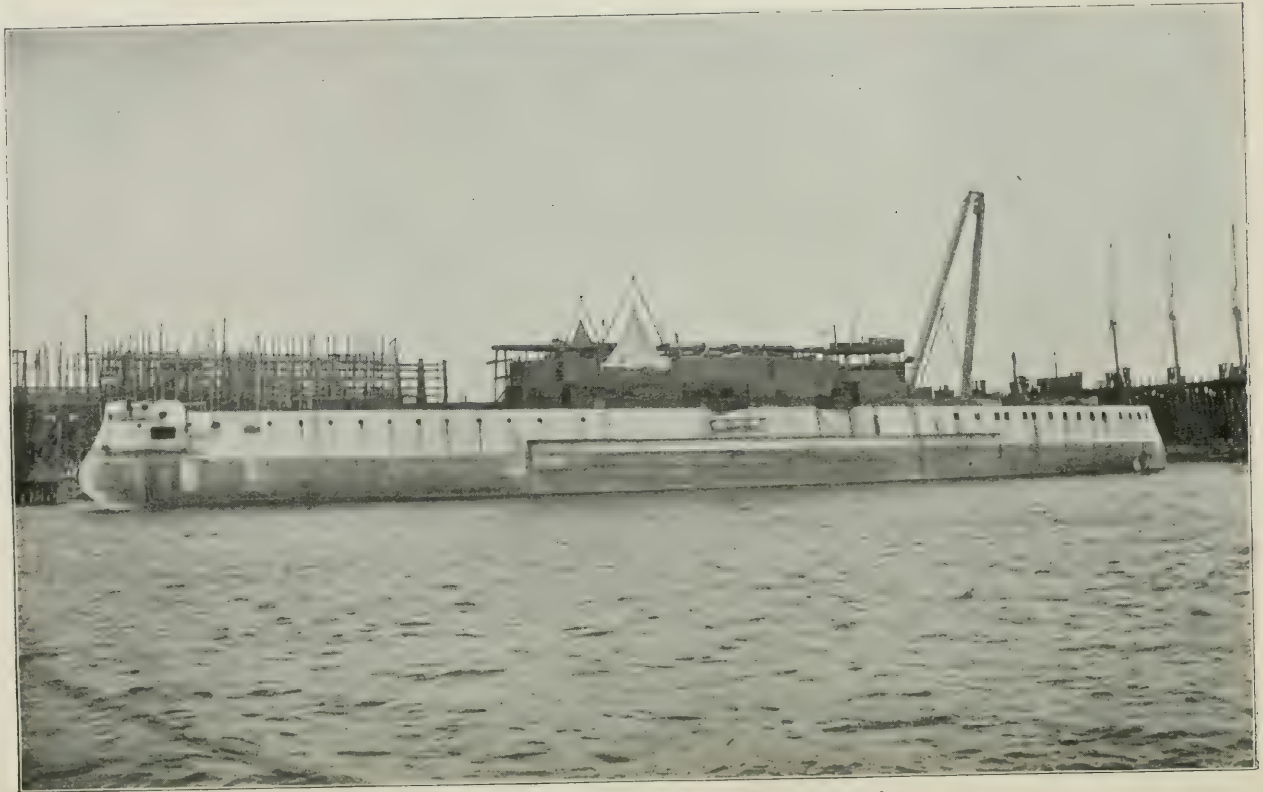
PROTECTED CRUISER "OLYMPIA."

marine engineers whether the incentives thrown out for the highest attainable speeds on acceptance trials constitute a wiser policy than offering higher prices accompanied by service-condition requirements. In many craft, particularly the lighter ones, such as torpedo-boats and catchers, the very light machinery and boilers necessitated by their character are so jarred and strained that their service efficiency is injured in the beginning of their career. We never hear of the successful Atlantic greyhounds having established their records on their trial trips, and yet their service records are most satisfactory. Such severe initial tests of engines do not seem judicious.

Dr. Francis Elgar, the distinguished British consulting naval architect of the Cunard steamships *Campania* and *Lucania*, in his paper on "Fast Ocean Steamships" read July 11 of this year before the Institution of Naval Architects, said :

> There are various standards by which the speed of ships is judged. We have the trial speeds, which may be determined by a series of runs over a measured mile, or by runs over various distances in smooth water at sea ; we have runs for a certain length of time in ordinary weather at sea ; and, finally, we have the average speed which a ship can maintain, year after year, over the whole of her voyage in all seas and all weathers. The last is the kind of speed now under consideration.
>
> The best results upon short trials are obtained with large engines and small boilers ; but the best results at sea are obtained with smaller engines and large boilers. This is also an instance in which short trials fail as a standard of what can be done upon a long voyage at sea.

The speed considered by Dr. Elgar in this paper would appear to be the most judicious one for comparing the values of vessels at war. A recent writer has remarked : "There is undoubtedly as much in the art of preparing a vessel for her speed trial as in that



COAST-LINE BARBETTE BATTLE SHIP "INDIANA," SEPTEMBER, 1893.

COAST-LINE BARBETTE BATTLE-SHIP "OREGON."

of grooming and caring for a horse that is to enter for a great stake." But how many splendid horses have been sacrificed to break a record !

Forced draft should only be tested to prove its efficient application and not used in the official speed trial. Whether the benefits of discovering all the *unnatural* qualities compensate for the injuries resulting from undue straining of boilers, engines, and hull is a question that perhaps cannot be easily decided.

The recent very successful naval review in New York harbor gave us an opportunity to appreciate our cruisers and gunboats. While the absence of any formidable foreign ships gave them perhaps a higher percentage of value than their due, it must be remembered that our battle-ships now building were also absent, and that our 5 battle-ships, 6 coast-defense monitors, 2 armored cruisers, 13 protected cruisers, 3 cruisers, 8 gunboats, 1 harbor-defense ram, and 1 torpedo-boat, form a very respectable nucleus of what the United States navy ought to be. For comparison with the leading naval powers, a report recently issued by the British Admiralty

LOW FREEBOARD COAST-DEFENSE BARBETTE "MONTEREY."

gives the following estimate of the present naval strength of Great Britain, France, and Germany, considered as the first, second, and third naval powers :

TYPE.	GREAT BRITAIN.				FRANCE.				GERMANY.			
	In Commission.	Reserve.	Building.	Total.	In Commission.	Reserve.	Building.	Total.	In Commission.	Reserve.	Building.	Total.
Battle-ships	24	10	9	43	19	5	8	32	11	3	7	21
Coast-Defense Ships	3	14	19	36	5	3	2	10	...	6	...	6
Cruisers	60	46	22	128	23	20	19	62	14	17	3	34
Others (not Torpedo-boats.)	74	44	...	118	50	62	5	117	19	5	1	25
Torpedo-boats*	...	...	...	186	...	...	...	229	...	...	...	153
Grand total	161	114	50	511	97	90	34	450	44	31	11	239
Annual Expenditure	$89,632,442 60				$51,870,071.00				$23,258,514.50			

*Approximate January 1, 1893.

"If America would keep her own peace with all the nations of the earth, and maintain her place in the vanguard of civilization, she must be at all times prepared for war. This is the lesson of history emphasized by the Rendezvous and the Review." These are the words with which Secretary Herbert closed his "Lesson of the Naval Review" in a recent issue of the *North American Review*. They indicate a liberal policy on his part, and we trust this expression of opinion, probably suggested by the responsibility of his office, will have a beneficial effect not only on those members of the naval committee who have cabinet aspirations, but upon all others who have voice and influence in determining what the appropriations shall be.

BRIDGING THE HUDSON AT NEW YORK.

By Gustav Lindenthal.

THE whole people of the United States and all the nations that trade with us are concerned in the question of a direct railroad entrance into New York city across the North river. Facility and cheapness of transportation into and from this city affect the cost of a large percentage of the whole commerce and travel of the United States. This fact is strikingly illustrated by a comparison of the bank clearings of New York with those of the whole country. They were in 1892 for New York city alone, $36,660,000,000, out of an aggregate for the United States of $62,109,000,000, or nearly 60 per cent. of the total.

The magnificent harbor and the accessibility of the city by water, which have made it the commercial emporium of the country, are, on the other hand, an impediment to inland transportation. New York is separated by the Hudson or North river from the American continent, to the south and west, almost to a degree of isolation. No other city in the world has such a peculiar location. Here is a great seaport, with an aggregate population and commercial importance second to none in the world, separated by a wide and deep river from all the rail transportation systems of the country, with but one exception,—the New York Central railroad, extending in a northerly direction. Thirteen railroads, with thirty-two lines of track to the south and west, stop at the New Jersey shore, opposite New York, which they can reach only by ferries and floats. The number of ferry passengers from the railroads, and from the local New Jersey population residing opposite New York, exceeds now 85 millions per year, and both the passenger and the freight traffic are growing at a rate which in less than fifteen years will double it.

Almost all the New York landings for these ferries are at the foot of narrow, filthy streets, in some of the worst-conditioned quarters of the city. During the day these streets are frequently blockaded with an almost impenetrable mass of teams and trucks, through which the landed passengers are obliged to make their way. In warm weather the air is filled with the pestilential odors from numerous sewers, terminating near the ferry landings. In winter the passage across the river is made dangerous by ice, fog, and collisions. It frequently happens that the ferry boats lose their way in the fog, requiring hours to find their slips.

Numerous schemes have been brought forward for either tunneling or bridging the North river. The first of which there is any record was by Thomas Pope, an ingenious and ambitious shipwright, living in New York eighty years ago. His scheme was for a single span arch bridge of wood, of which he published a plan and a description in quaint verse. But, like his plan and model for a similar bridge over the East river, it remained a curiosity. There was then no need for either bridge. Railroads and steamers were as yet unknown.

Over fifty years later (in 1867) when John A. Roebling made the plans for the existing Brooklyn bridge, he also made plans for a railroad suspension bridge over the North river; but nothing came of it. The public demand was then great, but the capital could not be obtained. Thereafter bridge and tunnel schemes followed one another in more rapid succession. There are now before one of the principal railroads concerned not less than eight plans and propositions from as many different chartered companies,—four bridge projects and four tunnel projects,—and more will probably follow. One of the tunnel projects was actually started in 1874. After a delay of five years by litigation, work again commenced in 1879. Of two tunnels, only two-thirds of the river portion of one tunnel has so far been built. It represents about one-fifth of the work intended, and its completion no one can foretell.

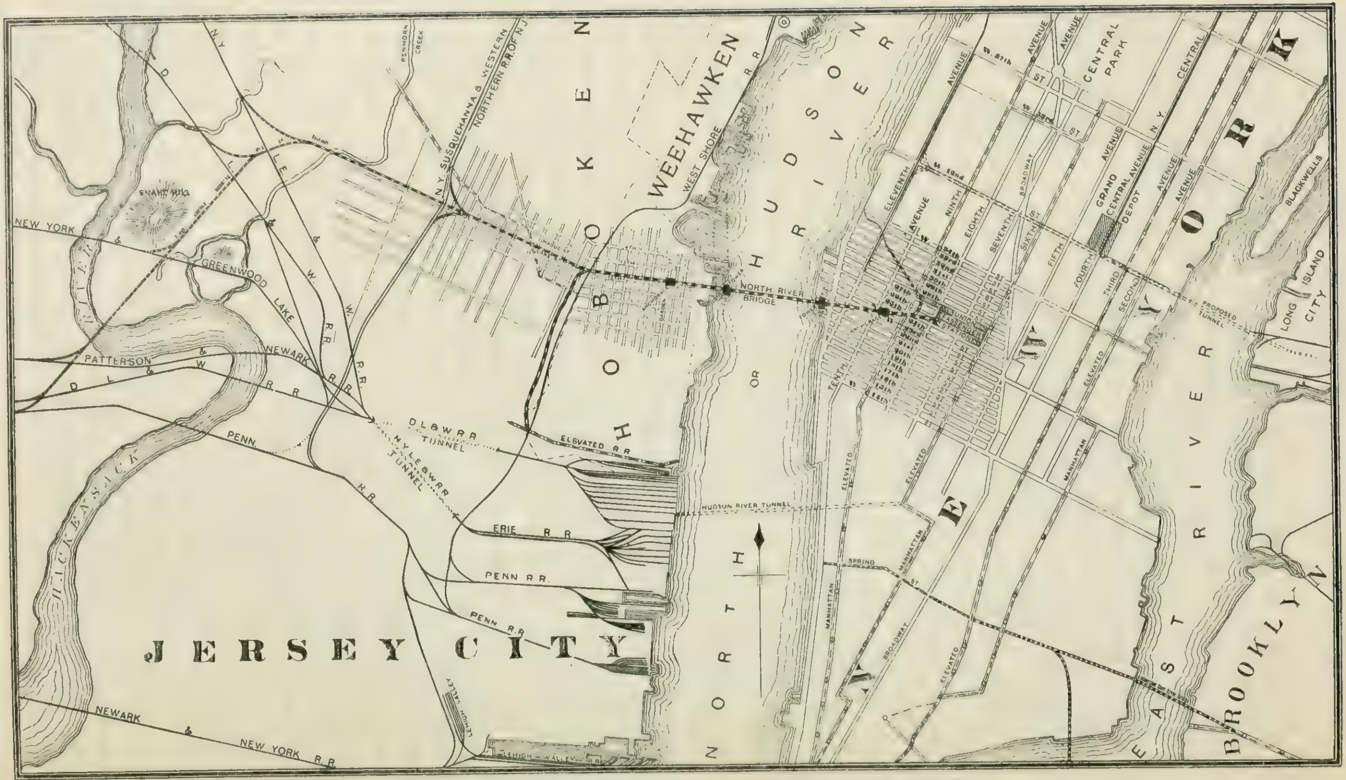
The failure, therefore, to construct a safer and more convenient crossing than by ferry is not the result of a lack of plans. Companies willing to build bridges and tunnels have blossomed and faded; the difficulties are great, and not generally appreciated or understood.

One of the questions naturally arises, Why do not the railroads in New Jersey themselves build, or aid others in building, a direct entrance into New York? From some knowledge of the subject, the writer will point out a few facts.

As long as the railroads in New Jersey are, all alike, obliged to use ferries and floats for crossing the North river, and no one railroad has any advantage in this respect over another, they will be satisfied with the existing order of things. The inconvenience is not felt so much by the railroad companies themselves as by their New York passengers. But the passenger traffic yields only the smaller, and with several the very much smaller, proportion of their revenues. By far the largest income and profit come from their freight traffic, as is the case with most railroads. A large amount of the freight for New York harbor never reaches the city at all,—namely, that tonnage transferred at tide water of New Jersey, Staten Island, and Long Island, from car to ship or vice versa, whether for trans-oceanic or coastwise trade. Moreover, the freight for or from New York and Brooklyn is carried on car floats to a large number of freight piers, equivalent to freight stations, along the river front of both cities. This method has proved so elastic, convenient, and comparatively cheap for most classes of freight, that neither bridge nor tunnel, with an elaborate system of tracks along the river fronts, would be an adequate substitute for it, nor would it offer any improvement or economy. The supremacy of New York as a seaport is owing, in a great measure, to the facility with which all these railroads can deliver and receive their freight at the nearest points of destination or origin in the two cities,—along a water front of over fifty miles in extent, accessible to all alike, and within three-quarters of an hour transfer distance from their tracks in New Jersey. Fog and ice on the river, although an impediment to passenger traffic, do not seriously interfere with freight traffic, which is merely delayed, but not much more so than elsewhere on their lines. The railroads have well-equipped plants of tugs, lighters, and car floats, and all their freight yards are arranged for this service.

It is their passengers who call loudest for a direct entrance into New York. But here it will be well to bear in mind that the railroads receive from the bulk of their passengers,—namely, from suburban travel—little more than one-half cent per mile, including ferriage to New York. While they receive from other than commuter passengers two and three cents per mile, their number is smaller, and the long distance passengers are the least numerous. For instance: the number of passengers from New York to Chicago, or vice versa, before the World's Fair travel commenced, averaged 180 per day (including the free travel) on the seven roads competing for through passenger travel.

Would a bridge or tunnel increase the number of passengers from Chicago, Washington, or other distant cities? Probably it would; but the increase from these alone would hardly pay more than a small fraction of simply the taxes on a New York terminus. In this respect it would not appear that the railroads in New Jersey



MAP SHOWING THE CONNECTIONS OF THE PROPOSED NORTH RIVER BRIDGE.

had lost much up to the present time by not running directly into New York, no matter what their passengers may endure or think.

These railroads have in recent years erected large and commodious passenger stations on the water front opposite New York. They have greatly improved their ferry service, and now run the largest and finest ferry boats in existence. But the railroads cannot improve the low river neighborhoods of New York, or the filthy and encumbered streets through which their passengers must reach the ferries. This is in great contrast with the railroad stations of less important cities on their own lines. But in none of them, nor in any other large city on this continent, is the cost of an adequate railroad terminus so great as in New York. It is too great to be assumed singly by any one of the railroad companies concerned. There is not enough to be gained by any one road for the financial burden involved. Their combined action for creating or financially aiding such an improvement is even less probable, if not altogether out of the question. All of them are obliged to husband their resources for much more needed improvements and additions along their own lines and in other cities. The difference in their financial conditions is great. Some of the companies enjoy high financial credit and others do not. The former not unnaturally decline to be financially interested in an undertaking in which the latter could claim, after completion, equal benefits with them under the existing laws, without having assumed, or being able to assume, their proportionate share of the financial burden and responsibility for construction. The work is beyond the usual character, in risk, time, and cost ; besides, there is among them great rivalry of business interests. Moreover the railroads see no advantage in entering into traffic-contracts, contingent on future conditions and events, not in their control, and that may come to plague and entangle them in some unforeseen manner.

No one road would or could relinquish its present methods, and send its entire business for New York over a bridge or through a tunnel. The railroads would send only such business as may result advantageously to them. Under such conditions they would however readily avail themselves of a direct entrance into New York, alike accessible to all, provided a separate company independent of them would build it. This is the only way to its realization, and for it large capital is indispensable. If the undertaking end with a floating debt,—so frequently the case with new enterprises,—it would be sure to terminate in loss to the investors. Numerous instances of this character can be quoted. Railroads can wait and use the ferries, while interest on bonds is coming due and defaulted, with the usual disastrous results.

Leaving this question, we turn to another: which is preferable, a tunnel or a bridge? It can be best answered from the following considerations.

Prompt and efficient first-class service requires that the passenger trains should come into New York at high speed and *en bloc*,—*i. e.*, without change of engines or crews in New Jersey,—just as the trains of the New York Central come into the Grand Central station at Forty-second street without change of engines in Harlem. High speed is a matter of course over a well constructed bridge, but not so through submarine tunnels, resting in the mud foundation of the North river. Locomotives and trains through them would have to move slowly. The difference in the volume of traffic transported through one and the other is similar to the difference in the volume of water discharged through a pipe at fast and slow velocities. A bridge track has greater capacity for traffic volume than a submarine tunnel track. Careful estimates show that a multiple track bridge, with corresponding terminals, will cost very much less than an equivalent tunnel arrangement, and can be constructed in a much shorter time.

A bridge will not interfere with the streets. The approaches and station can be on a high level above them, similar to the arrangement of the Pennsylvania railroad station in Philadelphia. Short connections can readily be made with the existing railroads in New York, and through them with the entire railroad system of New England.

The heavy grades of tunnels necessary for diving 100 feet or more under the river; the large, continuous, and unavoidable expense for pumping, lighting, and ventilating; the greater risk to human life in case of wrecks; the well-known aversion of mankind to submarine, chilly, and damp passages; the incessant roar; and other causes,—declare against tunnels for heavy railroad trains with locomotives. A change to smokeless motors for the tunnel would involve greater expense and loss of time.

Furthermore, tunnel terminal stations cannot be very well elevated above the street; and they cannot be on the surface of the ground, because there would then be grade crossings with the intersecting streets, and such would not be permitted any longer in New York city. Those now existing may in time be abolished.

Tunnel terminals, therefore, must be under ground and under the streets. We know from the London example what this means : dark, dingy, damp, and unhealthy quarters, full of smoke and noise ; dirt and soot everywhere ; the passengers glad to get into the fresh air and daylight.

Submarine work is the most uncertain in cost and time, and there is no record of a submarine tunnel for railroad purposes earning current interest on its cost.

It is probable, however, that submarine tunnels under the North River may come into use for local travel and rapid transit, by means of cable or electric motors, between the lower part of New York and Jersey City. The present ferry facilities may in time be supplemented for local travel by such tunnels. The Hudson river tunnel, mentioned above, and now for nineteen years under construction, would be suitable for such purpose, if completed. Another such tunnel, through the deep rock under the river, is proposed on a line from Montgomery street in Jersey City to lower New York, and thence to Brooklyn. Such tunnels would require no special ventilation, and could be kept clean and well-lighted.

But for heavy railroad trains, and for fast service, the locomotive will remain for a long time to come the cheapest motor we know of, and for such railroads a bridge is the most favored and best way for getting into New York.

A bridge, centrally located with regard to all the railroads on the New Jersey side and with regard to the business section of lower New York, would command about one-half of their passenger business, together with all the freight business for which it would be a time and money saving route,—namely, perishable and fast freight, food products, merchandise and high-class freight, storage and warehouse freight, and express goods whether for or from New York or New England. Such a bridge, accessible to Jersey City and Hoboken with their rapidly increasing population, and with their expanding system of electrical traction roads, would also have a large local traffic,—more than enough to make up for that number of the railroad passengers who would continue to use the ferries.

That, under these conditions, the passenger traffic would rapidly increase could be confidently expected from the experience with the Brooklyn bridge. One year after the completion of that bridge, in 1884, the number of passengers was 8,528,000, while in 1892 the number was over 43,000,000,—or in eight years five times greater,—and it is steadily growing. The Brooklyn bridge accommodates merely local traffic; no railroads are using it. For a North river bridge, centrally located, a much larger passenger traffic could be expected, with a growth proportionately as fast as on the Brooklyn bridge.

The growth of traffic on the elevated railroads of New York is another instance. It is phenomenal, and the rapidity of it was unforeseen. In 1880 there were transported 60,830,000 passengers, and in 1892, with the same length of road, over 213,000,000 passengers; and the traffic is still on the increase.

Other instances of the enormous growth of the transportation business in and around New York city could be cited to illustrate the necessity of providing, not only for the business now apparent, but for the rapid growth certain to result from increased comfort and facilities of transportation.

It must not be overlooked, however, that that rapid growth of traffic was greatly stimulated by low fares,—three cents over the Brooklyn bridge and five cents over the elevated railroads.

The Brooklyn bridge is only one mile long. Most passengers over it use the elevated railroads at either end, thus paying really eight cents for any trip over one mile and up to eight miles long. The average length of a trip is probably under four miles, including the bridge; and the rate per passenger mile would therefore be over two cents. This is a much higher rate per mile than the New Jersey railroads receive for suburban traffic, which would be the kind most increased by the bridge. From this it will be plain that the fares over the North river bridge will have to be low, and that the largest possible amount of local travel, which is independent of the railroads, and relatively the more profitable, must be aimed at for helping to earn interest on the invested capital. How important this consideration is will appear from the fact that the local passengers from Jersey City and Hoboken number at present forty one million, against forty-four million railroad passengers annually. One-half of all those passengers would save from five to thirty five minutes time by a bridge directly into the business heart of New York.

The principal advantage to the railroads would be from the growth of population and business along their lines in the vicinity of New York, stimulated by the superior accommodations of a terminus in New York and an unbroken rail connection to all parts of the United States, and from the saving of time. This service would be worth a reasonable charge ; but, competing with ferries or tunnels, and with a cheap system of collecting and delivering freight, the tolls would have to be adjusted for a large business at low rates ; otherwise the investment would not pay.

Space does not admit of discussing at length the questions of estimated cost and estimated revenues, or of the engineering features of such a work. They have all been carefully considered, and conservative estimates made by experienced railroad managers show, that the terminals in New York, large enough for all the railroads, would have to accommodate 2000 trains every twenty-four hours. This number may be exceeded in a few years after completion of bridge, from the resulting enormous stimulation of traffic. The existing thirty-two tracks from these railroads can be readily converged into six tracks on the bridge ; namely, two for suburban passenger trains, two for through passenger trains, and two for freight. To this would be added two tracks for electrical cars, or eight tracks in all from the beginning. An enormous saving in capital can be effected by building the eight tracks on one structure ; because its cost would be only 60 per cent. of the cost of four separate double track structures, other things being equal. The bridge itself is the least costly part of the undertaking. Its cost represents only a fraction—about one-fourth—of the cost of the undertaking in its entirety. In the case of the Brooklyn bridge, for instance, which has no terminals to speak of, the cost of the bridge structure proper was only one-third of the expenditure for the entire work.

The principal items of expense for an entrance into New York city will always be for the terminals, for damages, and for the costly right of way, although this expense can be economized for a bridge by arranging the tracks, if necessary, on two platforms, one above the other, limiting the land to be acquired to the smallest practicable dimensions.

The revenues from traffic are estimated at low rates : from five cents upward per trip for passengers, and correspondingly low for freights, the aim being to offer the railroads on both sides of the river a distinct advantage over present methods. The traffic revenue would be supplemented by a large income from the real estate which must be acquired for terminals. It would seem business folly to use such costly land merely for railroad tracks, when every foot above and below the tracks can be made to earn a profit from improvements built thereon, the cost of which has been included in the estimated total cost of the undertaking. The storage and warehouses and freight depots, built above and below the tracks, *and connected with them*, would save to the merchants and shippers of New York large sums for trucking and hauling freight through the streets. The rentals from them would be independent of the bridge tolls, which could therefore be made so low as to readily compete with ferries and tunnels. The total revenue from the whole undertaking, for the business in sight and without allowance for stimulated growth, promises from the beginning a very ample return on the invested capital, with careful management.

The tendency of railroad rates is still downward, and the bridge tolls would follow suit. This tendency has resulted in thrift and economies in the construction and management of such large properties, to an extent and in details not dreamed of twenty years ago. Closest management and thorough knowledge of the business are now essential to the success of such undertakings.

The fatal mistake is sometimes made, either wilfully or negligently, of underestimating the cost of a large work, to make it appear cheap and to attract capital. It has never yet resulted otherwise than in financial collapse and loss to investors. Delays from litigation and from periods of business depression are sometimes unavoidable and costly, and should be amply allowed for.

The successful financing and management of such a large work, with private capital, presents a formidable task, requiring the highest ability ; and all other difficulties, be they legal, engineering, or otherwise, are subordinate to it. The managers must needs have their enthusiasm tempered with prudence and foresight. There is, to-day, an abundance of engineering skill and constructing facilities for any great work, and with sufficient capital anything can be built.

A bridge over the North river, in spite of every difficulty, is not only feasible on the lines indicated, but, as the writer has good reasons for believing, will be realized in the not distant future.

THE INVENTOR OF GAS-LIGHTING.

By William Fletcher.

AMID the bustle and confusion of these high-pressure times, we, who are reaping the innumerable benefits which have been dearly bought and handed down to us by our predecessors, seldom stop to think of those who have rendered such services in the past. Yet there are hundreds of souls who have lived and labored, leaving the works of a useful career as their eternal legacy, whose biographies can never be written ; and the names even of these worthies will never be known. Such has been the fate of men who have lived in the past, and such is likely to be the lot of many who are living at the present time. Among those who are doing the greatest service, and in return receive the smallest amount of recognition, we think the faithful assistants of our great engineers claim a place. Some writer has said : " Many engineers owe their reputation to the unacknowledged skill of the assistants whom they had the good fortune to enlist."

The name of James Watt has been honored without limit, which has our approval, but we must bear in mind that Watt was always surrounded with clever assistants, and we believe that very much of the fame and wealth that fell to his lot was largely owing to the excellent coadjutors who rendered energetic and valuable services during the whole of his business career. The foremost place in that honorable rank we must assign to William Murdock, who for upwards of half a century was Watt's most skillful and esteemed assistant. Watt has had numerous biographers ; Murdock has not one. He is one of the many patriarchs of mechanical engineering whose services have never been adequately recognized. Not only is Murdock's ingenuity nowadays rarely mentioned in connection with Watt's career, but some of this clever assistant's inventions have recently been erroneously attributed to Watt.

In order to celebrate the centenary of the invention of gas-lighting, and to help in some measure to place W. Murdock in his true position among the illustrious inventors and engineers of the past, we may make a rapid survey of his leading inventions, allowing his experiments in gas-lighting to claim our chief attention. It has often been predicted that this system of illumination is doomed to give place to its more brilliant rival, the electric light, but in spite of these prophesies gas-lighting appears to be holding its own; while the manufacture of coal-gas is certainly on the increase, owing to its almost universal adoption for cooking and household heating purposes, to say nothing of the enormous consumption of gas by the thousands of gas-engines that are used for all manner of industries.

William Murdock was born at Bellow Mill, near Old Cumnock, Ayrshire, Scotland, in 1754. His father carried on the business of miller and millwright, and also occupied a farm on the estate of the Boswell family of Auchinleck, by whom he was much esteemed for his integrity and ingenuity.

During Murdock's earliest years he worked with his father, under whose tuition he quickly obtained a considerable amount of technical knowledge, and gained a reputation for intelligence and skill of no ordinary kind. The father and son between them constructed a wooden horse, worked by mechanical power, on which young Murdock traveled about for miles around the neighborhood of his native place, to the amazement of the inhabitants. Before Murdock was twenty years of age he designed and erected a handsome bridge over the river Nith, in Dumfriesshire, which still exists. As he was anxious to improve his position, and to become something more than a country mason and mechanic, he left Scotland in 1777 with the intention of seeking work from Boulton & Watt, at Soho. Upon his arrival in Birmingham he obtained an interview with Wm. Boulton, who gave him no encouragement, telling him they had no vacancy, as trade was slack. As Boulton was bidding the shabbily-dressed and foot-sore millwright good speed to some other shop he was struck with the peculiar appearance of the hat Murdock wore, and suddenly called him back and asked what it was made of.

"Timmer, sir," said Murdock, modestly.

"Do you mean to say it is made of wood?"

"Deed it is, sir."

"How was it made?"

"I just turned it in the lathie."

"But it is oval, man, and the lathe turns things round."

"Aweel! I just gar'd the lathie anither gait to please me, and made me one."

This was sufficient proof that Murdock was a mechanic of no mean skill. He was put upon a trial job in the Soho works, and quickly displayed his capabilities as a workman, which led to his engagement for two years at the rate of fifteen shilling a week. He commenced as an ordinary workman, but his diligence, sobriety, and skill soon led to his promotion, and it was not long before he became Boulton & Watt's most trusted co-worker and adviser in all their important mechanical undertakings. When Murdock entered the Soho firm Watt was well-nigh overwhelmed with the difficulties of getting his steam pumping-engines into practical use ; the worry and the vexations of the breakdowns in the machinery, Watt said, "would soon knock him up altogether." Murdock was appointed to superintend the erection and undertake the general charge of their engines in Cornwall, and he quickly overcame the difficulties that were more than Watt could manage.

Murdock traveled from mine to mine and often worked for long periods without rest and little food. His devotion to the work pleased Watt ; his open countenance and friendly disposition, combined with his anxiety to please, soon made him very popular with the mine-owners. Notwithstanding the long hours and incessant night work, occasioned by the superintendence of the engines under his charge, he found time to construct the beautifully simple model locomotive that we are so familiar with, which doubtless was the first successful road engine ever made in England. Watt had often talked of making a steam-carriage, which would have been an abortion, with its condensing apparatus, wooden boiler, and sun-and-planet motion. Murdock, with rare ability, discarded these cumbersome details, and produced the high-pressure engine. The first experiment was made in Murdock's house at Redruth in 1784, when the little model hauled a wagon around the room, the single wheel, placed in front of the engine, fixed in such a position as to enable it to run in a circle. The model had been continually in the possession of the Murdock family when, in 1833, it was purchased by Messrs. Richard and George Tangye. It is now in the Birmingham Art Gallery, and is still in good working order, although over one hundred years old, and when under steam is capable of attaining a speed of six to eight miles an hour.* This little carriage was made with Murdock's own hands, which makes it exceedingly interesting to engineers.

In the year of 1798, Murdock returned to take up his permanent residence at Soho. "His energies to further the interest and celebrity of this establishment were not used in vain, for they assisted, in no slight degree, in procuring for it a name celebrated

*"One and All," by Richard Tangye.

throughout the civilized world. His time there was so completely occupied by his mechanical pursuits that he devoted no time to recreation. The rising sun often found him, after a night passed in incessant labor, still at the anvil or lathe, for with his own hands he would make those articles he could not trust to unskilled ones." Among his inventions we may enumerate the following: (1) An apparatus for boring cylinders; (2) a new method of forming steam-jacketed cylinders; (3) the sun and-planet motion used on Watt's engines for procuring a continued rotative motion from a reciprocating engine, without the intervention of a crank; (4) the double D slide-valve and other valves used on Watt's engines; (5) a rotary engine, one of which continued in use for thirty years and worked well; (6) the locomotive engine already referred to; (7) a patented method of boring stone pipes for water; (8) a lift worked by compressed air; (9) the cast-iron cement so extensively used in the old days; (10) the oscillating engine.

Murdock is still better known to the public, and most deservedly so, by his invention of applying the light of gas from coal to economic uses. For the first experiment Murdock procured a kettle, which he placed on a fire in his workshop, after filling it with small coal. The spout of the kettle had a perforated thimble on the end, through which the gas issued, giving a good flame when lighted. Many experiments on a larger scale were carried out, and eventually Murdock's house and offices, at Redruth, were lighted with coal-gas, made in an iron retort and conveyed in pipes to the different rooms of his house, where it was burned at proper apertures or burners. This appears to have been the first application of gas for useful purposes, although the gas had been discovered and obtained both naturally and artificially more than half a century before. "Murdock had a gas-lantern in regular use, for the purpose of lighting himself home at night across the moors from the mining engines that he was erecting, to his house at Redruth. The lantern was formed by filling a bladder with gas, and fixing a jet to the mouthpiece of the bladder, which was attached to the bottom of a glass lantern, with the bladder hanging underneath. After various experiments, by which he proved the economy and convenience of the light so obtained, compared with that from oils, resinous, or animal substances, he perfected his apparatus, and made a public exhibition of it, by lighting up the front of Boulton & Watt's works, at Soho, on the occasion of the general illumination for the peace of Amiens, in 1802." This brilliant illumination was received with immense enthusiasm. Watt would have nothing to do with any patents relating to gas, hence Murdock derived no advantage from the extended use of the new system of lighting beyond the honor of having invented it. Two large cotton-mills in Manchester were fitted up with gas in 1805, and another mill in Leeds soon afterwards. It became necessary to enlarge the Soho works to make room for the manufacture of the gas-making apparatus. Murdock published a paper describing the advantages of the new light in 1808, for which the Royal Society presented him with their large Rumford gold medal. The retort first employed by Murdock was made of cast-iron of a cylindrical form, placed vertically in a common portable furnace. The inconvenience of removing the coke from the vertical retort led to the adoption of a horizontal cylinder. These retorts were also made of cast-iron, from 12 to 20 inches diameter, and from 3 to 7 feet in length. The form of retorts used at the cotton-mills of Messrs. Phillip & Lees was similar to that first mentioned, but larger in size, and a cage was adopted to facilitate the discharge of the coke; this cage was let down into the retort previously to charging it with coal, and was afterwards lifted out by means of a small crane, when the process of distillation was completed, bringing out with it the whole of the coke. Murdock tried a retort having an opening at each end, but this was found to cost more, and he adhered ultimately to the simple horizontal retort, which came into general use, and continued so, with little alteration in principle up to recent times.

As soon as it was proposed to light the streets with the new method, the idea was ridiculed by Sir Humphry Davy, who asked if the dome of St. Paul's would be used as a gasometer! Sir Walter Scott made clever jokes about those who proposed "to send light through the streets in pipes" and to light London "by smoke," though he was glad enough, not long afterwards, to make his house at Abbotsford light and cheerful on wintry nights by the use of that very "smoke." Wollaston, a well-known man of science, declared "that they might as well attempt to light London with a slice from the moon." *

When the House of Commons was first lighted by gas the architect imagined that the gas ran on fire through the pipes, and therefore insisted on the pipes being placed several inches from the wall, for fear of the building taking fire; we are also told that

* "Invention and Industry," Dr. Smiles.

"the members might be observed touching the pipes with their gloved hands, and wondering why they did not feel warm." In 1814 Westminster bridge was first lighted with gas; Glasgow was lighted in 1817, Liverpool and Dublin in 1818, and Birmingham not until 1826. "So completely was Murdock absorbed at all times with the subject in hand, that he was regardless of everything else. When in London explaining the nature of his substitute for isinglass, he occupied very handsome apartments; he, however, little respected the splendor of his drawing-room, and proceeded with his experiments quite unconscious of the mischief he was doing. One morning his landlady, calling in to receive his orders, was horrified to see her magnificent paper-hangings covered with wet fish skins hung up to dry, and he was caught in the act of pinning up a cod's skin to undergo the same process. He and his fish skins were at once thrown out of the house into the street." * During the erection of an apparatus for heating the water for the baths at Leamington, Murdock met with a severe accident; a heavy cast-iron plate fell upon his leg and crushed it; he never completely recovered from the effects of the accident, but as soon as able, he was at work at the Soho factory again.

Although Watt ignored the use of steam as applied to navigation, Murdock and the younger members of the firm took up the question, and devoted themselves to the manufacture of engines for steamboats, with success. Dr. Smiles says: "In the midst of these repeated inventions and experiments, Murdock was becoming an old man; yet he never ceased to take an interest in the works at Soho. At length his faculties experienced a gradual decay, and he died peacefully at his house at Sycamore Hill, on November 13, 1839, in his eighty-fifth year. He was buried near the remains of Boulton and Watt, and a bust by Chantrey served to perpetuate the remembrance of his manly and intelligent countenance."

* "Murdock's Inventions," Buckle.

THE ART OF SUCCESSFUL ADVERTISING.

By Ernest H. Heinrichs.

ADVERTISING has become generally recognized as a necessary and important adjunct to every business, trade, profession, and mercantile or commercial enterprise. The cobbler advertises his handiwork on the window-ledge ; the grocer puts his best stock of vegetables on the sidewalk ; the clothier, the dry-goods man, and the furniture-dealer fill the pages of the newspapers ; the actor seeks to attract the attention of the public in flaming posters, and the manufacturer advertises his specialties in the trade papers and magazines. The time-worn axiom that good goods do not need advertising is now relegated into the deepest recesses of the business man's vault containing memories of the past, and is brought out only to serve as a dampener upon a too persevering advertising solicitor. In this age of keen competition, it is not likely that any man will have a purchaser for his goods simply because they have the characteristic of excellence. He must promulgate their distinctive advantages or their superiority.

To do this successfully, he must advertise. There are as many ways of advertising as there are roads leading to Rome, and the question is how to find the right way.

To the writer it seems that the first point to be considered is, how much money will the capital of the business to be advertised permit to be used for this purpose ? This point, once disposed of, will immediately suggest another one,—how may this sum be expended to the best advantage, or, how can the business be advertised most effectually with this stipulated sum ?

The thorough study of these points is of the utmost importance. There must be method pursued in the manner of advertising, if it is to be profitable, else there will be absolute failure. One who decides to embark in any enterprise invariably makes it his first business to find out how much it will cost him to make a start. The same principle applies to advertising. It is a business in itself, the management of which requires the greatest care and attention.

Some people say that they give the papers an advertisement occasionally just to get on the good side of them ; others, that they give some man from the papers an advertisement, because he is a "jolly, good fellow." In fact, one gentleman remarked to the writer some time ago that "there is a good deal of sentiment connected with advertising!" Now there is much truth in what this gentleman said, and more is the pity. It is this kind of advertising which is dangerous, inasmuch as it reflects upon advertising as a legitimate business, because it deteriorates to a form of bribery, and it disheartens as well as disgusts both the reputable publisher and the honest advertiser.

Every bona fide publication which sets apart a certain amount of space for advertisements disposes of this space to its customers at a stipulated price, for which price the purchaser of the space has the right to expect a certain return in the shape of orders. It is a business transaction pure and simple,—a contract entered into between the publisher and the advertiser, by which the one expects the price of the advertisement, and the other to increase his business. It is a fair exchange, and that is what every business transaction should be. Such sentimental transactions as have been cited before are unbusinesslike. Advertising contracted for through sentimental reasons may be termed an act of charity, and charity and business are no relations. This sentimental advertising has been the foundation for the establishment of very many publications, and many of them have maintained a precarious existence under these conditions. Fortunately, however, their existence has seldom been a long one.

Having decided how much money may be spent in advertising, the next question is, how and where is it to be done? To settle this question is very difficult, for the reason that the mediums for advertising are legion. Many old advertisers believe that advertising by circular letter affords the surest and best way to reach a customer. They argue that if they send out a stamped envelope with a type-written page or two of matter inside, the recipient will surely read these pages. Then there are others, who are not particular about having the matter even type written; they are satisfied to get up an elegant advertisement, have a printer strike off as many copies as they have customers on their books, and then they send these circulars to their customers. Again, there are those who now and again get up a catalogue, in which are set forth descriptions in general and in detail of everything they sell, and they send these catalogues wherever they hope to catch a probable purchaser. Then there are firms who rely entirely upon their agents and representatives to advertise their goods by word of mouth. Most advertisers, however, consider all these methods auxiliary; they help a little, but they do not do much good alone. It may be safely asserted that newspapers, magazines, and trade papers, are now recognized as the standard advertising mediums.

The object of advertising is to make certain statements known to the public at large. Hence the more people see the advertisement the more thoroughly does it fulfill its mission. Of course this opinion may be questioned by the advertiser of specialties, who desires to reach a certain class of people only, but this statement is meant to apply to advertising in general, though it would require merely a slight modification to apply to all cases. Nevertheless, one fact, borne out by the most successful advertisers in America and in Europe, is that what is broadly understood by newspaper advertising is the best and cheapest advertising that can be had. The term "newspaper" includes of course periodicals of every class.

In choosing a publication some people have very peculiar ideas; if they see a paper with a large number of advertising pages, they take it for granted that an advertisement in such a paper means money thrown away, because the advertisement will be crowded out of sight. This is a mistake. The best papers, as a rule, have the largest amount of advertising; hence they must be the best advertising mediums. The best papers are apt to be the most widely read, so that advertisements in them must of necessity become widely circulated, which is the great object of advertising. To this reasoning it may be replied that it does not follow, that, because an advertisement is circulated among ten thousand people, ten thousand people will read it. Certainly not, but an advertisement circulated among ten thousand people stands a better chance of being read ten thousand times than an advertisement circulated among only five thousand people. Apart from this deduction of simple logic it must not be forgotten that advertisements are read with as much interest as any other portion of a newspaper. This may not always have been so, but it is nevertheless true to-day. It may be that the busy man will carelessly pass over the advertising columns of the daily newspaper, but the housewife will read them twice and thus make up for his neglect. But take the popular magazines of to-day, the advertising pages of which are truly remarkable, not alone in their appearance, but also as regards their contents. Does any one dare to assert that an advertisement placed anywhere in these pages is a lost investment? The advertising pages of these periodicals represent from month to month the most striking reflection of the commercial, the industrial, and the financial, as well as the intellectual, progress of this country, and the intelligent readers of these publications are just as much interested in the persual of the advertising pages as of the essays, stories and other features.

The regular classification of the advertisements is a matter which is not always regarded with as much importance as it deserves. Experience has shown that such a classified arrangement of the advertisements is of great advantage to the publisher, to the advertiser, and to the reader. The advertising pages are the main source of profit from any publication, since through them comes the money to pay the dividends. For this reason alone the publisher ought to take the greatest pride in his advertisements, their appearance and their arrangement. They are the hens that lay the golden eggs and should be gently handled. A systematic, well-arranged method observable in the advertising columns of a publication is certainly liable to encourage the advertiser, and a strict classification of all advertisements as far as practicable will prove a great stimulus to new business. If, for example, there were just ten clothiers in one town, of whom nine advertised in a paper, is it not more than probable that in case these nine advertisements were paraded in succession every day before the tenth clothier, he would soon hasten to join the throng? But if the advertisements of these nine had been scattered indiscriminately over the paper, the odd man might never have been induced to advertise. It was only the fact that he found himself left out that prompted him to enter the fold. It is human nature all the world over.

The advertising pages of any publication may be justly compared with a market, or with the business district of a large city. In the market you notice at one end all the butchers, at another all the fishmongers, at another all the green-grocers, fruit dealers, and so on. In the city you notice the dry-goods district, the jewelers' district, the commission man's district, the brokers' district, the woolen manufacturers', etc. Now why should the different advertisements not be arranged in the paper in the same way, when the arrangement in the market and in the city has been a success for years and even centuries? If a man intends to purchase a bill of dry-goods he goes to the dry-goods district, because he knows, that there, by going from one store to the other, he is sure to find what he wants. He asks for prices and compares them. This applies also to advertising. If one wants to buy a certain article, he is apt to look into the paper for an advertisement of it. If, on turning the pages over, only one advertisement is found representing the goods the reader wants, he will not be satisfied and will look for another paper. The first paper may have had several advertisements of these goods, but scattered and hard to find.

This leads to the conclusion that a business man, having decided to advertise, and having set apart a certain sum for this purpose, should go to that publication which is read by the largest number of people interested in his business, which most probably will be that publication which has the most advertisements and pays the most attention to the manner of setting up and arranging the advertising pages.

The advertising rates in the best publications are very low. Many people, and even some advertisers of experience, will doubt this statement, but that does not detract from its correctness. The trouble is we expect too much from an advertisement. It must not be supposed that a single advertisement, for which perhaps $50 has been paid, is going to fill a store with customers for a year to come, thus bringing a profit on the investment of probably ten hundred per cent. Most people are satisfied, if they make one hundred per cent. on their invested capital, and everybody should commend them for their modesty. Why, then, should a larger profit be expected from an advertisement than from any other investment?

Advertising once commenced, must be kept up, and if conducted with the same thoughtfulness, the same care, and the same business methods exercised in any other enterprise, an advertisement will always prove a profitable investment.

There is one other feature connected with the business of advertising, which, although the writer has so far not made mention of it, is nevertheless of no less importance than the others. This is the manner of composing an advertisement. It is impossible to form any set of standard rules as a guide for the composition of advertisements, except in so far as that they should in all cases be so worded that they will at once attract attention and be read. To be brief, concise, clear, and to the point in writing an advertisement is undoubtedly commendable, and a plain statement is always more liable to carry weight with the reader than a long string of ambiguous phrases, which have no defined meaning when analyzed.

ELECTRICITY

Conducted by Franklin L. Pope.

ACCORDING to the account given by a correspondent, Great Falls, Montana, appears fairly entitled to the distinction of being called the Electric City. At Black Eagle falls, three miles above the town, an immense dam has been thrown across the Missouri, and hydraulic works and power houses erected. Not only are the street-cars propelled and lighted by electricity from the power-houses, but they are heated as well by electric radiators placed in each car. Elevators, printing-presses, cranes, and all kinds of machinery are operated by the ubiquitous force. There are automatic excavators, electric pumps, and electric rock-crushers. A not uncommon sight on the streets is a mortar-mixer attached to an electric wire leading down from a pole. The restaurants cook by electricity, the butcher employs it to chop his sausages and hamburgher, and the grocer to grind his coffee, and so likewise does the tailor to heat his goose. The subtle fluid is a welcome blessing in every home; the housewives run their sewing machines and heat their flatirons by electricity; they bake their cakes in wooden electric cake-ovens that can be set away on a shelf like pasteboard boxes. They have electric boilers and broilers and teakettles. What a singular anomaly when one pauses to think of it: that of broiling steaks and heating flatirons through the instrumentality of a waterfall!

THE most powerful search-light ever constructed was exhibited at the World's Fair by a German manufacturer. The diameter of the reflector is 150 centimeters, and the lamp requires an electric current of 60 volts and 150 amperes. When placed on the roof of the Manufactures building, at a height of 230 feet from the ground, the light was seen as far distant as Milwaukee, Wis.,—a distance of 85 miles. A newspaper could be read by its light at a distance of ten miles. The principal use of these powerful lights is for coast-defense, as by their aid it is possible to detect approaching troops or vessels while at a distance of at least twenty miles.

IN a recent address Sir G. C. Stokes observed that the electro-magnetic waves of the luminiferous ether are strictly of the same nature as those of light, but that an enormous difference exists in respect to the lengths of the respective waves; in the case of light they are about one fifty-thousandth part of an inch, while the electro-magnetic waves which have thus far been investigated vary from a few inches to many yards.

EXPERIMENTS which have been made in France by M. Massin have led to the conclusion that the efficacy of the ordinary form of plate lightning-arresters is dependent upon the distance between the plates, and also upon the degree of polish of the opposing surfaces; that air-gap comb-protectors are less liable than plates to become short-circuited, and that they dissipate quietly a charge which is insufficient to spark across; and that thin paraffine paper is preferable either to gutta-percha or mica as a separator for the plates of plate arresters.

IN the central station of the Waukesha Electric Light Co., a 100 horse-power two-cylinder Otto gas-engine has been used for the past year, driving a dynamo supplying 53 arc-lights of 2000 nominal candle-power each, on a circuit nine miles in length. The consumption of gas is said to average 20.6 cubic feet of gas per arc-light per hour. Of course the direct consumption of the same amount of gas would give nothing like as much light as an arc-lamp. In an experimental test, it is stated that 36 arc- and 300 incandescent-lamps were run on 1400 feet of gas per hour, and in another test 36 arc- and 425 incandescent-lamps were run on 1600 feet of gas per hour. While the gas-engine has been much used in electric work in England, it has apparently received less consideration in the United States than its importance warrants. With gas at a price of $1 per thousand feet, as it is in some American cities, it certainly seems as if gas-engines might be advantageously and profitably employed for driving dynamos, especially in installations of moderate size.

ONE of the most recent novelties in electric lighting is a lamp which has recently been perfected known as the "incandescent arc." It is virtually an arc lamp which burns in an atmosphere of carbon vapor, in a closed chamber. It operates equally well with the direct or the alternating current, and in its practical applications, as well as in its principle, seems adapted to fill an intermediate place between the incandescent and the arc lamp. With a given expenditure of energy, it produces about twice as much light as the large incandescent lamps now in use, the volume and intensity of the illumination being approximately equal to that of an arc lamp enclosed in a ground glass shade. It possesses important advantages over the arc lamp for interior illumination, in that the diffusion of light is much more satisfactory; it is absolutely noiseless, even when run by the alternating current, while a single pair of carbons has been found to burn for more than 100 hours without readjustment or renewal. On the other hand, its superior economy, and the whiter tint of its light, render it better adapted than the incandescent lamp for the illumination of large spaces, such as railway stations, stores, public halls, and the like. Arrangements have been made for manufacturing the new lamp on a large scale.

A SINGULAR scheme of electric lighting is about to be carried out in Antwerp. Water is to be distributed from steam pumping stations, at a pressure of 775 lbs. per square inch, and used to drive dynamos in small district stations by means of turbines. These are to supply the local consumers through a low pressure, two wire circuit system. It is figured out that the cost of coal per 16-candle-power per hour will be only .025 cent. We doubt it.

A DISTINGUISHED French mathematician has proved that with the exception of the so-called unipolar machines, the construction of a continuous current dynamo without a commutator is an impossibility, and that therefore it is useless for any one to waste time, effort and money in trying to invent such a machine. No doubt this is true, but at the same time, one cannot but recall the circumstance that it is only a few years since one of the most distinguished electricians on the other side of the Atlantic published a conclusive mathematical demonstration of the impossibility of subdividing the electric current for incandescent lighting without such a waste of energy as to render the scheme wildly impracticable. We would not disparage the value of mathematics, but it must never be forgotten that, as some one has aptly put it, mathematics is only a mill, and hence the kind of grist you get out depends altogether upon what you put in.

A PROMINENT English engineer contends that experience has shown that silicon-bronze is the best material for electric light and power conductors. The spans may be made 50 per cent. longer than even with iron, while less costly insulators are required. This metal is already largely used abroad for telegraph and telephone lines.

IN a paper read before the International Patent Congress at Chicago, on the Influence of Electrical Inventions, Mr. T. D. Lockwood remarked that from the time of Dr. Gilbert, the court physician of Queen Elizabeth, down to the discovery by Faraday, in 1831, of the correlation between electricity and magnetism, the record of electrical progress was not one of invention, but of what during that period was infinitely more precious and valuable,—a record of the discovery and application of principles, each successive discovery being the direct consequence of those previously made, and each in turn aiding materially in the evolution of the next. Until these principles had become well understood, it was not possible to make an intelligent application of them. Discoveries are achieved only in the fullness of development; to this the individual is secondary; the discoverer is in a great degree but the mouthpiece of his time. The telegraph has revolutionized the business methods of the commercial world; it has done more to realize that one touch of nature which makes the whole world kin than any other one product of the century of applied electricity. To the telephone, said Mr. Lockwood, we must attribute the renaissance of electrical experimentation which has found fruition in all the victories of the years which have succeeded its introduction. As to its own utility to the world, consider the time saved to each of the 232,000 telephone subscribers of the United States by the 2500 conversations constituting his average portion of the 600,000,000 held over the telephone in a single year; the loss of time in travel saved to the overtasked business man by the long-distance service. In no other country, said Mr. Lockwood, is there a patent system which so carefully fosters invention, and makes easy the path of the inventor, and in no other country is the record of invention in general, and electrical invention in particular, so magnificent as in the United States. It may be that if other countries would try our way, they would find it beneficial. Why not try it?

AT a competitive trial of skill between telegraph-operators, absurdly called a "tournament," which took place last month, one of the most interesting features was a test of the capacity of a receiving instrument technically known as the "audison,"—a small instrument fitted to the head of the operator, giving a sound which, although perfectly distinct to him, is wholly inaudible to any one else. In our opinion it is high time that the use of a receiving instrument of this character became general in the telegraph service. Under the present condition of affairs it is almost literally true, that he who runs may read. Hundreds of telegraphic stations in hotels, railway-depots and other equally public places, are equipped with noisy sounders, enabling every message that goes over the wire, to or from that or any other station, to be read by any person within hearing who is able to do so. There is not the slighest attempt to preserve the secrecy of communication, which ought to be one of the all-important requirements of the service. There are thousands of ex-operators and other persons in the community, who can read these signals as easily as they could read a bulletin-board, and there is obviously nothing whatever to prevent any one of them from obtaining information of other persons' business or personal matters in this way and using it for their own advantage. It is a state of affairs which calls loudly for immediate reform.

THE paper of Professor Thompson on the possibilities of telephoning across the Atlantic, read at the International Electrical Congress at the World's Fair, is exciting considerable interest among electricians. We do not regard it as very probable that this feat will be accomplished in our day, and it is a question whether it would be of much use if it were. A recent critic calls attention to the fact that on account of the difference in time, London and New York have only about three hours of the business day in common, and hence the tariff that would have to be charged would necessarily be prohibitive, inasmuch as the earnings of the three hours would have to pay for fixed charges and working expenses for the whole twenty-four hours. The Paris–London telephone line, on the other hand, seems to have met a long-felt want, and is kept in active service. It is stated that for ten francs 450 words can be transmitted over this line, while only 48 words can be telegraphed for the same price. The cost of transmitting the same number of words in the United States over a distance equalling that between London and Paris, and indeed, much farther, would be only half as much, or $1, besides which the address and signature would be sent free, instead of being counted and charged for.

It is very much to be regretted that the exhibitors of electrical apparatus at the World's Columbian Exposition have in so many instances neglected to place some person in charge who is capable of giving an intelligible explanation of the apparatus. Some prominent exhibitors go so far as to prevent, if possible, the visitor from gaining any information of value by his own efforts. This fact has given rise to no small amount of unfavorable criticism and comment among the foreign technical visitors. It would seem as if such a policy must in the end prove a very short-sighted one, and we think it will.

The total amount of capital which has been invested in central-station plants in Great Britain is estimated at no less than £4,500,000. At the present time, however, there is in that country a decided tendency manifest to place all central-station supply systems in the hands of the municipal governments.

The Boston public library now contains a remarkably large list of works on electricity, and especially relating to the telegraph and telephone. A catalogue of these last was published in the April bulletin of the library.

Three years ago the bright little son of a Maine clergyman, not more than a dozen years of age, while on a visit to Boston with his father, became deeply interested in the operation of the trolley cars, and suggested to the writer of these notes that he thought it would be a good idea to build an electric fire-engine that could propel itself on the street-car tracks, and be run off on the pavement and set to work wherever electric power could be derived from a trolley wire, or by a special electric connection located in the vicinity of each hydrant. It is now stated that such an electric fire-engine has been built by an engineer of St. Paul, Minn., and exexhibited to the fire commissioners of that city. It is said to weigh less than half as much as a steam fire-engine of the ordinary capacity, while its power may be readily increased to almost any extent. With an electric supply available at almost every street corner, as is now the case in most large cities, it would seem as if the steam fire-engine must of necessity soon be superseded by its electric rival.

It is announced that the Milford and Hopedale electric railway, which has been operated for a long time by the storage-battery system, with results which have been claimed to be highly satisfactory, has been compelled to suspend operations, in consequence of an injunction obtained by the owners of the controlling patents on storage-batteries, which the courts have decided to have been infringed by the apparatus in use on that road.

Experiments have recently been made with a view of determining whether the quantity of heat developed in the rheostat —which is one of the necessary evils in the operation of electric railway motors—is sufficient to be of any practical assistance in warming the atmosphere of the car. The conclusion arrived at was that the amount of heat which could be thus realized is not sufficient to warrant the expense of providing special rheostats. Incidentally, however, these results go to show that the actual loss of power due to rheostatic regulation, as compared with commuted field-windings, is much smaller than has usually been assumed.

One of the longest electric railways in the country is that from Oakland to Hayward's, California, a distance of fifteen miles. The cars on this road make a speed of 35 miles per hour, and the distance between the termini has been run in 35 minutes. Some of the cars run an average of over 200 miles per day. Great care is taken in respect to the inspection and repair of the motors.

It is said that the largest dynamo-electric machine in the world is that which furnishes power for the intramural electric railway at the World's Fair, its capacity being 1500 kilowatts, equivalent to 2500 horse-power. The capacity of the railway for heavy work bids fair to be pretty thoroughly demonstrated before the close of the Fair.

Out of a total of some 300 miles of electric street-railways now in operation in the various countries of Europe, more than one-half is equipped with machinery of American manufacture. The over-head trolley system is used on about two-thirds of the total mileage.

A twin conductor cable for high speed working on submarine lines has been invented by the electrician of the Post Office Telegraphs of Great Britain, which is expected to eliminate much of the difficulty hitherto experienced from inductive interferences, and to greatly extend the distance through which it is possible to speak by means of the telephone. The principle of the invention is understood to reside in the particular geometrical form and relation of the two conductors with reference to each other and to the insulating medium in which they are inclosed.

The Postal Telegraph Department of Great Britain had a very interesting and instructive exhibit at the World's Columbian Exposition. Among other articles worthy of note may be mentioned some of Cook and Wheatstone's early apparatus of 1840; a section of the first five-wire telegraph, laid in a wooden trough between Euston and Camden in 1837; sections of the first submarine cables laid between England and France in 1850; and a large number of specimens of historical and obsolete apparatus illustrating the evolution of the art of telegraphy during the past fifty years.

It is but a few years since all the finer and more accurate instruments for electrical measurements were imported. To-day, it is admitted that the best ammeters, volt-meters and watt-meters in the world are of American manufacture, and a large export trade in these articles has sprung up. The methods so successfully applied in the manufacture of American machine-made watches have been adopted in the class of work referred to, with the most successful results.

One of the arc-light dynamos exhibited at the World's Fair is capable of supplying 125 2000-candle-power lights, giving a potential of 6250 volts at 525 revolutions per minute. The current is about 9.4 amperes.

It has been found by experience that the return circuits of electric-railway systems are best made of iron when buried in soils containing clay and quicksand, while in dry gravelly and sandy soils, copper is preferable.

The plan of using large multipolar dynamos directly connected with the driving engine, which appears to have originated with the Swiss engineers, is gradually gaining in favor in all countries. One of its most important advantages is due to the saving of floor space,—no small consideration when a plant occupies costly real-estate in the heart of a large city. One plant now in actual operation consists of four 75 horse-power engines, the same number of 50-kilowatt dynamos, and a switchboard, these being all contained in a room 20 feet by 18 and 8 feet high, with plenty of space for the attendants to get at any part of the machinery for repairs or renewals.

One of the principal journals devoted to electro-technical matters now announces that its columns are printed from type set up by type-setting machines driven by electric motors. A critical examination of the work shows that it is very well done, the uniformity of the spacing and the clearness of the type, which is new every issue, giving the page a very attractive appearance.

ARCHITECTURE

Conducted by Barr Ferree.

IT'S over at last; the World's Columbian Exposition has gone into the past. This gigantic enterprise that cost a fabulous sum of money, that consumed the energies of an army of men, that occupied the thoughts of the thinking world for months, even for years, and, last, but not least, has elevated the city of Chicago to the utmost pinnacle of fame, has made her name a household term the world around, and has poured uncounted wealth into her coffers, albeit the work of the receiver and the sheriff has not been idle in her midst during the past half year,—this gigantic enterprise, after a brief but brilliant existence of six months has come to an end amid universal rejoicings. Ends do not usually create feelings of this nature, but the Columbian Exposition had lived its life, accomplished its duty, made some rich, others poor, and it was time that it should go and leave less conspicuous influences to determine the coördination of affairs in this country and the rest of the world. While the Exposition failed, in many minor particulars, and some major ones,—to wit, architecture,—as an illustration of what the American mind has accomplished, while our contact with foreign nations through it has not been as close and as varied as it might have been,—surely the Midway Plaisance and its mess of messes is not to offset this,—it was undoubtedly a very striking display of our national resources and our national growth and character. More than anything else it was an American exhibition; through it we have learned to know ourselves as we perhaps did not know before. If it was lacking in any one feature, it was in that it did not bring out our weaknesses in contrast with our points of strength, It was not a complete picture. It showed only our glories, pointed out our greatness, and left us with a false notion of our importance. Perhaps this could not be helped; perhaps it did no harm, but at all events it was an omission. And yet it was a misfortune that, while the exhibition so well illustrated American resources, it did not do so more completely. The exhibits should have been more systematic; they should have been better arranged and, above all, there should have been an abundance of brief, popular handbooks that would have made the resources of the exhibition of value to every one. It may have been too much to ask for these for a collection brought together for so short a time, but if a thing is worth doing at all, it is worth doing well. However, all this belongs to the past and cannot be helped now. As it was, the exhibition contained more than any one man could master in twice the time. This was another source of weakness, for one is continually running against people who saw everything in three days. We verily believe that one could see more at the Columbian Exposition in three days than at any other place on earth, but that would not be seeing the Exposition. The Fair has been an enormous success and every one concerned in its making can take his full share of the credit. Even the New York *Sun*, in the last month of the Fair, patted Chicago on her back and remarked that she had done well. If higher praise than this can be found on this planet we should be glad to know what it is and where it can be had. With this Chicago may well feel satisfied.

A SECOND visit to the Fair confirmed our earlier impression, that while it has a wonderful power and dignity, considered as a whole, the buildings individually, speaking generally, are wanting in detail and abound in faults of design. We have previously had occasion in these pages to refer to this and more need not be said. The Court of Honor is unquestionably a superb piece of architecture, the view towards the peristyle being especially dignified, with the stately statue of "The Republic" immediately in front. The reversed view is not so good, though that towards the Colonnade, between the Palace of Mechanic Arts and Agricultural Hall, is almost as pleasing. The reverse of this view, however, is something to be ignored, since the vista is closed by that miracle of astounding architecture, the Illinois State building. A continued acquaintance with the Fair-grounds likewise confirmed our earlier impression that, while the landscape gardening, of which so much has been said, is unquestionably very fine to look at, and adds immensely to the appearance of the buildings, it is totally unsuited for practical purposes. One got wearied before one got anywhere. The distance to a good restaurant, or what passed as such, from almost any portion of the grounds, was appalling. The intramural railway landed you scarcely anywhere that was convenient. Everywhere there was walking, walking, walking. Short cuts were impossible, because you were invariably shut off by a lagoon or a lake. Transportation by water was costly and not always convenient. There was, in fact, no end of the trouble put upon the visitor by this much bepraised and belauded landscape gardening. The highest test of any architectural work is its utility. The usefulness of the grounds should have been the first thought of the designers. Every effort should have been made to save steps, or, if an elaborate arrangement was desired, some cheap, rapid, and desirable surface carriage should have been provided. People who do not know what landscape gardening is must, after the Fair, think it something very dreadful, based on the idea, if possible, of making people go twice the distance to reach a certain point when they might only go half by going another way. It is very beautiful, we admit, but very horrible to the sightseer. And these were the people to be consulted. An architect does not make a design irrespective of the uses to which his building is to be put; that must determine its ultimate form. By neglecting this elementary idea in the laying out of the Columbian Exposition the art of landscape gardening has been degraded in the public estimation, and from a noble art for a noble purpose has shown itself incapable of realizing the fundamental elements of all work of practical utility.

THE enclosures surrounding the national exhibits in the Manufactures building at Chicago were not altogether successful. This was a matter, we believe, that was left to each nation to settle for itself, but however it was done, the work did not, as a whole, reflect any particular credit upon those concerned in it. The enclosures built by several of the smaller nations were, artistically, little better than fences. Russia had a somewhat imposing pavilion in its national style of architecture, ugly enough in itself, but interesting for its novelty and because it was a well-meant effort to produce something. Spain did as well as could be done with an application of Moorish arches from the mosque of Cordova, which were cleverly enough placed under the gallery that covered most of the Spanish exhibits. The galleries of the Manufactures building were one of the great failures of the Fair; no one would go up to them, and they thoroughly ruined anything placed under them owing to the utter disregard of lighting by the architect. Spain was especially unfortunate in this respect, and it was the more remarkable since the Exposition itself was in honor of Spanish energy put forth four hundred years ago. Italy and Belgium had interesting Renaissance pavilions, which, while not being pretentious at all, fulfilled their purpose thoroughly well. In some respects the French pavilion was the most noticeable of the series, as it certainly was the most pretentious. It was the only one that gave any indication of resting upon an intelligible idea, which was to form a series of frames or enclosures to particular exhibits. But, while the idea was good, the execution of it was not, for the figures that supported the cornice were much too large for the work they had to do, and the whole effect was much too heavy. The entrance was well managed, notwithstanding some very bad wall paintings, but the effect of the half-dome was totally ruined by being made of canvas, a circumstance quite obvious to the eye. An architectural construction that waves to and fro with every breath of air is not one that commends itself to thinking people. But, however one may be disposed to criticise the architecture of this enclosure, it is impossible to do anything but give the highest praise for the admirable and artistic manner in which the exhibits were arranged. Of all the sections in the Exposition, the French department of this building alone was arranged as a whole. The best possible use was made of every exhibit, and while many of these were crowded, the general effect was very fine. This section pointed a lesson which other departments might well have taken advantage of. The German pavilion was conspicuous for its great Armbruster gates, huge pieces of wrought-iron that were extremely impressive. The pavilion itself was constructed in a receding fashion, going backward and upward in a manner that was sometimes a little confusing. Its architecture, on the whole, was uninteresting, as was also that of the adjoining Austrian pavilion. Least satisfactory of all,—an abomination of abominations,—was the clock tower placed in the center of the building. Its position was exasperating, since it was deliberately placed in the middle of the most crowded part of the building. And its architecture? Bad, bad, bad.

THE displays of household art at the Columbian Exposition were somewhat confusing. One had scarcely got into the Manufactures building before he found himself in the midst of the Italian furniture. This was packed into twice the area it should properly have occupied. It was very much carved, with a superficial richness of effect the Italians seem to be thorough masters of. Anything worse than this stuff it would have been hard to find. The carving which covered almost every inch of surface was very bad indeed; the inlaid furniture was, if possible, worse, and the whole display was as uninteresting and depressing as could be imagined. It is not at all indicative of the distribution of correct taste throughout this country that the sales in this department seemed to be very large. The low prices of some rather pretentious-looking articles of furniture doubtless accounted for a good deal of this. France, Germany, and England were well represented in furniture, France leading in point of quantity and variety of exhibits, but with Germany a good second. England, though represented by only a few firms, made an excellent display. The furniture was good, the carving well suited to the pieces to which it was applied, the designs well chosen and graceful, the inlaying, of which there was quite a display, rich and appropriate, and the whole effect very good. The exhibit of Messrs Hampton & Sons, who sent a reproduction in carved oak and modeled plaster of the banqueting-hall in Hatfield House, was especially noticeable. This very costly display reflected infinite credit upon its makers, who deserve the greatest credit for their enterprise. In Germany the most conspicuous exhibit was a suite of three rooms in the German Renaissance of the sixteenth century. These were decorated and furnished with an astonishing amount of richness, and a throne-room at one end, containing furniture loaned by the crown of Bavaria, was unsurpassed in gilding and the splendor such ornament suggests. The German display also included sundry small rooms, several of which were furnished in excellent taste. The French exhibit was more extensive than either of these, but it was by no means as successful or as pleasing as the English. Most of the furniture shown was covered with tapestry or brocade. There was relatively little carved work; some charmingly painted pieces were shown. All these foreign displays included many huge articles of furniture quite unsuited to the average American house, and also, we should think, to the more pretentious American dwelling. The displays of American furniture, on the contrary, were eminently useful and "homelike." It was furniture made to be used, and sold at, apparently, not too high prices. Most of it was in hard wood, of very excellent design, and very pleasing finish. Though it could not compare, in richness of effect, with the more elaborate displays of foreign countries, it was very creditable and very satisfactory.

THOUGH the display of architectural appliances at the Fair was not large, it happened that the collection of elevators was varied and extensive. This followed, naturally, from the size of the buildings and the utilization of their roofs as promenades and for restaurants, and similar purposes, all of which necessitated the use of elevators. Most of these were treated as exhibits or parts of exhibits by the manufacturers, and very good exhibits they were. This, of course, helped to distribute the displays throughout the grounds, but, after all, most of them were limited to three places, to the Transportation building, the Electricity building and the Palace of Mechanic Arts. The variety of elevators was so large that it seemed to us we might well improve a portion of our time at the Fair by studying them. At least here was one subject one could learn something about, for the material was ample and the opportunity for study apparently sufficient. Alas and alack for our good intentions! Sundry bold bad men, belonging to various elevator-makers, had disguised themselves as would-be purchasers, or country cousins or similar innocent folk, and had sought to find out from the representatives of other elevators full particulars concerning the idiosyncrasies of their machines. It seems almost incredible that such wicked folk should exist, but we were assured that they do and did. The immediate result of this was a demand, from the elevator-man, for your biography and your standing in the community. They did not inquire as to your commercial rating, nor did they ask after the condition of your bank-account; they professed simply to wish to know whether you were a proper person to talk with about their machine. As we happened to be "doing" the elevators *incognito*, this circumstance somewhat baffled our studious inclinations, as we quite failed to see how any man could invent a machine, patent it, and then keep the construction wholly to himself. The net results of our labors were, therefore, much more limited than we had hoped. Briefly stated, we think the result of our researches may be stated thus: Firstly; there are four sorts of elevators: those worked by steam, by electricity, by hydraulic power, and on the pneumatic system. Secondly, the last elevator you see is the best, is provided with more and better safety apparatus than any other, is the most economical, the swiftest, the best built,—in short, the one to buy. We do not know if these propositions are especially valuable or not, but that is the net result of "doing" the Fair *incog*.

A STRANGE medley of architectural models one might have collected at the Columbian Exposition if one had had the time and if the objects were themselves collectable. We have frequently taken occasion to deplore the lack of systematic architectural displays at the Exposition, but taken first and last, a goodly number of architectural illustrations were contained in it. In the Anthropology building, which housed a most interesting collection of curiosities, were a number of models of the dwellings of primitive peoples. Some of these were made by the Department of Ethnology, which started out with brilliant plans and failed to put them into execution. But disjointed as its work was, it accomplished a good deal and secured a number of beautiful models. The actual houses of the American Indians which were placed outside this building were not so successful as they might have been though they were genuine buildings. The casts of prehistoric structures from Yucatan, while very interesting in themselves, quite lost scale by being placed in the open air and thus in direct contrast with such enormous structures as the Agricultural Hall. Various other models and reproductions were scattered throughout the exhibitions. There were models of fish-houses and fisheries in the Fisheries building. There were schools and schoolhouses in the educational displays. There were charitable institutions and prisons and hospitals in the Anthropology building. There were flour-mills and breweries, the last large and beautiful models of the greatest interest, in the Agricultural building. There were models of railroad-stations and train-sheds in the Transportation building. There were models of Japanese palaces and temples, veritable works of art in wood and metal and executed with the utmost nicety and skill, in the Palace of the Fine Arts. There were models of farms and of stables and of cow-sheds in Agricultural Hall and in several of the State buildings. Wherever one might go, one came across an architectural exhibit of some sort, and if they had all been brought together in one place, they would have made a most interesting show. But this was not to be, and we have no doubt that, closely as we searched for them, many interesting pieces of work escaped us. What will become of these things now that the Exposition has closed, we do not know. Many of them will doubtless be thrown away; others will return to their makers to slowly find their way to the attic and junk-shop; others, again, will be housed in the Columbian Museum that Chicago has founded to take care of anything anybody will give to it. The architectural value of a good many of these things is not very high, but they all indicate some architectural idea, and, if brought together, would form a really valuable collection.

In dismissing the Columbian Exposition from these pages for the present, a word or two may be devoted to the critics who have been having so much to say during the past few months. The quantity of slush that has passed for criticism of the Fair which has been printed in the daily, weekly, and monthly press of this country is prodigious. Editors, apparently, have accepted almost everything, and ability to compose art criticisms does not, if one may judge by the work given the public, rest on a discerning mind or a clear understanding, Had 90 per cent. of this stuff been left unwritten and unprinted, the world of art would be better off to-day. From this unsavory mess it is only possible to take one or two illustrations, but they shall be typical ones. A good deal has been said by unthinking people about the Transportation building and its decoration,—a not unnatural circumstance, since it is clearly the most novel and interesting of all the Fair buildings. Yet very few of the people who have undertaken to instruct less wise persons about it have tried honestly to understand it, while an even smaller number appear to have kept in mind the fact that the building was built to be decorated in the fashion it is, and that unless criticised from this standpoint it cannot be criticised at all. Yet a writer in *The Nation* finds it "an entertaining salad of styles" and his only positive expression of opinion is a quotation from the London *Times* to the effect that it is "shabby." Into the mental operations of a person who writes in this style it is impossible to enter, but it is to be regretted that *The Nation*, which counts a number of perfectly competent critics of painting and architecture among its contributors, should not have delegated the task of describing the buildings to one of these, instead of accepting the utterances of a man who has no opinion of his own but must reproduce the remarks of an unknown Englishman. Quite in the same line is *The Art Amateur*, a paper which prides itself, we believe, on its artistic excellence and appreciation. It is covered with regret in admitting that the Transportation building "is a complete failure," though "architecturally the building is far from bad." It is not to be wondered at that after this it can find little that is good in the color decoration that is the *raison d'être* of the building. It is quite true that the architecture of the building is "far from bad," but it is also true that the person who wrote these words did not try to look at the building as its author intended it should be looked at, and that he was so wedded to preconceived ideas and precedents that a noble, fresh, original work like the Transportation building could make no impression on his mind.

RAILWAYS

Conducted by Thomas L. Greene.

THE annual reports of railways now being published for the fiscal year ending June 30 prompt the remark that there is a gradual improvement shown from year to year in the make-up of these exhibits. More information is now given to the public and the statistics are arranged so as to be better understood. The old feeling that the income and financial *status* of a company was "nobody's business" is giving way to the belief that an honest statement is one of the best defenses against Wall-street or legislative attacks. The work of the statistician of the Interstate Commerce Commission, though in some important respects subject to criticism, has had its effect nevertheless upon railway opinion regarding reports and also upon more correct methods of accounting. Two roads—the New York Central and the Denver and Rio Grande—have introduced a new table. It might be called a treasurer's statement, as it is intended to show in brief the sources of the moneys received during the year and their disposition. This, it will be noticed, is more than an income account, since it embraces the cash received from bonds or from borrowings, as well as the surplus earnings from operation. But where reports do not give such a table the interested bondholder or stockholder or railway-man can make up one for himself by comparing the corresponding items of the general balance-sheets for two years. Thus increase in assets would consist of increases in cost of road and other like items, together with decreases in liabilities. On the other side should be put increases in liabilities such as in bonds or accounts or bills payable, and also decreases in assets, which latter item, for bookkeeping purposes, is equivalent to an increase in liabilities. The test of the accuracy of such a table is in having the charges on both sides foot up the same. The use of such a table is in revealing things which the ordinary statistics do not touch. For example, the Chicago, Milwaukee and St. Paul report states the charges to capital for equipment and improvements for the year at $2,877,817, while a comparison of balance-sheets shows the increase in the item cost of road to have been $3,678,381. This leaves an expenditure of about $800,000 unaccounted for, and though doubtless this represents merely some shifting of other items, it is better to have all such discrepancies set out fully in public reports.

THE Wabash also furnished a good and clear report. This company occupies a peculiar position in that it has no construction account, for the reason that it is mortgaged to its full value or even more and cannot issue new bonds. Hence improvements—and every road must improve its property in some way—are paid for from earnings, while the distinction between betterments and operating expenses is not drawn as closely as with other railways. The Wabash by this method is steadily though slowly bringing its roadbed and equipments up to the best standard in its section. Payments on its debenture B bonds would be a fatal mistake, for that would deprive the company of the money absolutely needed to spend upon the road in order to compete cheaply and safely with its rivals. It may also be mentioned that the statistics in the Chicago and Northwestern report are very full and put the investigator in possession of all the facts needed to form an intelligent opinion. It is only those roads which have something to conceal that are willing to put blind or misleading figures in their annual reports.

THE business depression and loss of gross earnings brings up prominently the question of wages. Many leading roads have cut down pay-rolls and discharged men in the shops. The proposed reduction in the wages of train- and engine-men has been openly resisted or grudgingly yielded to for the moment. In a few cases this reduction has taken the form of a loan to the road by the employés of 10 per cent. of their wages. Since all companies and firms are suffering from the financial and business situation, it is right that railway employés should accept losses with their employers. Sometimes, however, there is coupled with this reduction the further theory that employés should receive less wages generally and permanently. Advocates for lower wages point to the fact that the ratio of operating expenses has steadily grown larger; this is owing in part to higher wages, but in greater part to a general fall in rates. If rates were but fair and well maintained, the recent increases in wages would not be such a burden. The employés, on the other hand, argue that if wages were permanently reduced and the same "cut-throat" competition allowed to continue, it would not be long before the lower level of expenses would be reached by the declining revenue through a further reduction in rates, when the same question would again come up. If it is a question of wages and rates—it is said—it might as well be fought out on the present level of payments as on a scale of wages 10 per cent. lower. From this point of view the problem of reasonable and fair tariffs for the passenger and freight traffics, if we could solve it, would at the same time help greatly to solve the present labor problem also. It ought to be and doubtless is the wish of every railway manager to pay good wages. Railroading is a hard and dangerous trade, and those who follow it ought to receive corresponding remuneration. Moreover good wages are necessary for the maintenance of that discipline which is essential to the safety of goods and passengers. While, therefore, railway managers are compelled by the force of present circumstances to consider reductions in wages, they should and usually do recognize the claims of their men. They should also consider the other side of the problem—the question of increasing the earnings. Our companies are too often assailed by legislatures and find their revenues reduced thereby, while a national law at the same time takes away their only legitimate defense—combination. Every legitimate means should be employed to educate public opinion in this direction, not only as a matter of justice to carriers, but also because the matter involves the question of safety and the best service to the community.

IT is a little surprising that no American road has adopted the English system of insurance for employés. The Pennsylvania and the Baltimore and Ohio have excellent relief departments under which the funds of the men are administered by the companies, free of charge. A number of roads have built hospitals and employed surgeons for the care of those injured; while all companies spend money for the relief of disabled employés in various ways. Yet it is all indefinite and somewhat of the nature of charity: it forms no part of the implied contract of employment. When the employers' liability act was passed in England, the British railways took alarm—needlessly, as it has turned out. They instituted departments for insurance against accidents, death, and old age. Membership was made compulsory and servants had to waive their rights under the act. In return the companies agreed to contribute to each fund an amount each year equal to the total contribution of the employés. These funds are managed by committees formed from railway officers and servants, and the scale of payments is figured out by actuaries according to the statistics of accidents in past years. These funds have now accumulated balances amounting to several millions of pounds sterling. In the accident department, for example, each trainman pays 6 cents per week. He is entitled to $500 in case of death by accident or permanent disability; or weekly allowance of $5 when temporarily disabled. The officers and clerks receiving regular salaries contribute 2½ per cent.

of their stipends to a superannuation fund. Upon retirement each receives as a pension a percentage of his salary, that percentage varying with length of service; after thirty years' service it amounts to half his salary. There is also provision for death. Another fund provides pensions for the wage-earners. When it is remembered that railway servants of all classes in England receive much less pay than our own men, these sums are very liberal and are to be measured by the small payments required. If a man leaves the company's service in good faith he receives back his own contributions only. If he is discharged for fraud or dishonesty he forfeits the whole, at the option of the company. In this simple plan of insurance may be found one of the reasons for the excellent discipline on the English railways. The company testifies to its interest in its employés by contributing to their insurance from its own earnings. In the United States, unfortunately, there has grown up a feeling of antagonism between the corporation and the employé. What can be done to bring these two great forces into better sympathy with each other? The plan of insurance against death, disability, and old age, through the help of the company, would do much to bring about a reconciliation, to say nothing of the relief to the injured from the point of view of humanity. Why does not some American company try this plan?

Of the large commercial and financial questions awaiting solution in the United States none is more complicated than the anthracite problem. Practically all the hard coal in the United States is embraced in about 480 square miles of the State of Pennsylvania. This territory divides itself into three regions, the Wyoming, the Lehigh, and the Schuylkill. From the first region the coal is carried principally by the Delaware, Lackawanna and Western, the Delaware and Hudson, New Jersey Central, and the Erie roads. The Lehigh Valley is the main coal-carrier from the region of the same name, while the Philadelphia and Reading's holdings in the Schuylkill region comprise nearly half of the entire coal area. As the carriage of this hard coal has from the first been the main business of these carriers, it was early seen that the ownership of the lands would secure continued tonnage. So auxiliary companies were in most cases formed to hold these lands whose stocks were held by the railways. The present constitution of Pennsylvania forbids this, but the railway charters antedate the constitution.

These several railway companies found themselves rivals in supplying the anthracite trade, and as the capacity of the collieries opened was greater than the demand, more coal was thrown upon the market than could be consumed, with a consequent fall in the price. Agreements with each other to restrict production would avail for a time, but when one company got ahead of its agreed proportion, some other would cut prices to keep up its percentage. This in brief has been the history of the anthracite wars. Gradually the price of anthracite declined until it was just high enough to pay a return on the lightly capitalized companies, including the money invested in the mining subsidiary companies. As the price of coal sought this level under overproduction and the working of well known economic laws, the rate of freight did not change correspondingly; so it came to pass that the profit to the carrier from transportation was enough for the purpose even after deducting the deficits of the mining companies which were run at a loss. But while the great companies held the majority of the coal-lands, a part was still in the hands of private owners—individual operators, who after paying the public rate of freight had not enough left from the selling price to meet expenses. Hence one large firm sued the Lehigh Valley before the Interstate Commerce Commission for a reduction of tolls, forming a most complicated case which the Commission decided against the railway. The decision however has never been enforced.

Meanwhile the Reading company was in a peculiar position. Under the leadership of the brilliant McGowen it had acquired the large coal area mentioned, yet at the same time the rival carriers, though owning less coal land, had expended their capital in building railway lines and in other ways to reach more extended markets. The Reading, with an ownership of over 40 per cent. of the whole territory, found that it could carry and sell less than a quarter of the anthracite output. Moreover the cost of mining is slightly greater in the Schuylkill than in the other regions. The reorganization of the Philadelphia and Reading Company followed in 1886 through the issue of "preference" bonds, whose interest was payable only if earned. In 1892 control of the Reading passed to Mr. McLeod and his friends, who succeeded in combining the Reading, Lehigh Valley, and New Jersey Central. With the acquiescence of the uncontrolled companies the price of coal was advanced a year ago about $1 per ton, at wholesale. Mr. McLeod's ambitions led him to seek further markets for Reading by planning to control several important roads in New England, as well as by a purchase of all the output of the individual operators whose "free" coal had always been a menace to prices under the high toll system. Under various ambitious schemes Mr. McLeod was led to borrow largely, while attempting to secure the favor of the preference bondholders and to keep up the price of such collateral as he had hypothecated by declaring the interest on these income bonds earned. Not being able to borrow longer, the crash came and Reading was again put into the hands of receivers, where it still remains.

The future of Reading depends largely upon the future of the anthracite trade. High prices imply restriction, while no company is willing to give up any of its earned trade to favor Reading. A comprehensive plan for distributing the coal tonnage requires a combination of all interests which has never yet been attained. Meanwhile many expensive collieries are run at a loss merely to supply coal tonnage to the owning railway. In fact the high freight tolls on anthracite invite new competition and were a principal factor in bringing about the present complications, yet they are hardly likely now to be materially changed without a severe struggle. The cost of mining is on the average about $2 per ton on the cars, including all charges, interest on plant and royalties, the freight toll to tide water being $1.75 per ton for a haul from 100 to 150 miles. What the situation will bring forth no one can say; perhaps a better agreement, either by a unification of interests or possibly through another coal war.

THE shocking railway accidents of the last two months, resulting in loss of life and property, point out a defect in our system. These accidents were due to various surface causes: in one case the block-signal operator let in the following train before the preceding one had left the block, precipitating a bad collision; another collision was caused by an employé substituting one meeting place for another in the train order on a single-track road; on another road a bridge undergoing repairs was not protected by cautionary signals to trains to slow up and was left in a weak condition while the gang went to dinner; and so the list grows. It is not possible in a limited space to discuss each accident in detail, but one thing is of overshadowing importance—discipline. Were these employés competent? Were they selected for their responsible positions with care? Were they watched? Were their infractions of the rules punished? In short was discipline fully maintained? In most cases of accidents lack of discipline and an inferior class of men, are the underlying trouble. We have in the United States no such well-trained and well-disciplined force of employés as serve to keep the English railways comparatively free from accidents. For this state of things the railways themselves are partly responsible. They hire mere boys for telegraphers who have the handling of train orders in which a mistake may mean death. They allow a signal-man to fool with his semaphore without punishment. They are not thorough with their men. The railway excuse is, however, often good. To keep good and well-trained men costs a great deal of money, directly and indirectly. The average superintendent is judged by his economy, false, though that standard really is. Bond interest and dividends might disappear if expenses were not kept down. Yet safety costs money. Passenger fares in the United States are on the average high enough, but freights are often too low, especially when rates are "cut." One part of the responsibility for a lack of safety must therefore be put upon the public, which wishes its transportation at such low prices as not to admit of paying comparatively high wages to the best men. Each road, however, must be judged separately in the matter.

EVERY new thing has its dangers, and the new theory about railway receiverships discussed last month is no exception. If receivers for a corporation may be appointed at any time, at any hour, without notice, on application of men who happen to be creditors to a small amount (and every company owes money) and on consent of the president or other officer of the company, then it is evident that a few unscrupulous men, by taking advantage of their position, may put any corporation in great peril and cause widespread loss. It is equally true that we have very little of such a procedure to record. Great reliance is properly put upon the honesty of our higher judges, before whom such applications come. Those judges are men of character as well as learning, and may be relied upon to reject dishonest attempts to wreck corporations. Officers of our large companies as a rule are also trustworthy men; though the possibility spoken of adds one more to the many reasons why stockholders should choose their officers with the utmost care. Business must be carried on by men, and the managers of large interests must be given discretionary power. So far the practical effect of the new theory of railway receiverships has been undoubtedly for good.

THE several collisions which have occurred on roads equipped with block signals and on those without that device, have again raised the question of the utility of that system of signaling. As to the more simple form of blocking, wherein a semaphore signal is moved from "safety" to "danger" by the hand of the operator on the report that the block is clear, certain railway men are not yet convinced that we have gained much over the plan of depending upon the rear brakeman. Will not the signal-man in the tower blunder as easily as the brakeman? Do we not know by experience that merely substituting one man for another does not solve the problem of safety? These questions, however plausible on their face, do not go quite to the bottom of the question. In adopting simple blocking a road does indeed substitute one man for another, but the important point is that we substitute also a rigid set of rules which can be lived up to for a system which in the nature of the case must be more or less elastic. An engine-man is not looking for a rear brakeman, but he is on the lookout for a fixed signal at a stationary tower. The tower-keeper should be governed by instructions which he need never have any excuse to violate, and whose violations, if made, can be known and punished. In short, semaphore signaling reduces collision signals to a system.

ON the other hand, the rear brakeman is often asked to go back under circumstances of hardship. Or, perhaps a dangerous and slippery trestle is in front of him, where safety is in question. We ought not to put too much stress upon poor human nature at \$600 or \$800 a year. Then, although the standard rules say just what he shall do under ordinary circumstances, they do not say what should be done when anything unusual occurs. The rules do not cover the point. When we rely upon the judgment of an employé in cases of sudden danger demanding knowledge of trains, keenness of mental sight, and coolness, we must expect that these qualities will fail the average trainman in a given proportion of cases. But by substituting a space interval for a time difference between following trains, we in fact introduce a possibly perfect system where before there might be doubt of safety even under the most favorable conditions.

MINING & METALLURGY

Conducted by Albert Williams, Jr.

EXTREMES of economy in the cost of any operation or manufacture are apt to be misleading and often tend to miscalculations on the part of too-sanguine projectors of similar undertakings—or rather undertakings of a similar general character but in which all the conditions are not precisely duplicated. Still, it is always interesting to note these extreme cases; for, while they fail to establish standards for work under average or less favorable circumstances, they at least serve to show what may be done under the best conditions. Further, it should not be forgotten that in no one works where a number of considerations must be taken into account—and this applies with especial force to the mining and reduction works, where the conditions are very complex and variable—is it likely that *all* of these conditions will be of the best. In some one or another detail there will be always an advantage somewhere else. So those mines and works which give the most economical results are the ones which have the best total average of favoring conditions, which, though indefinitely numerous in minor details, are, in the case of mines, grouped under these main heads: size, character, and richness of deposit; scale of operations; ease of working, with reference to hardness or toughness of rock, amount of timbering needed, explosives, tools, or power-drills, etc.; nature of openings, whether open cuts, shafts, inclines, or adits; altitude and general surrounding topography; climate; presence of water; temperature at great depths; facilities for using water and electric power; available local supplies of timber, fuel, etc.; communications with points of supply and distribution, as to means, time and freight rates; character of labor; wages and cost of living; ruling market prices for all items of supplies and products; and, of course, skill in technical management and in business administration. It will be easily seen that under each of these and other principal heads a long list of minor details could be enumerated, all of which have more or less weight in the final result. At a large metallurgical establishment the complexity of influencing conditions are even greater, for while some of the mining conditions are dropped, a greater number of new ones are introduced. Then, again, taking a broader view, not only do the conditions at the mines and metallurgical plants mutually affect each other, but they are also themselves affected by a series of apparently outside influences, such as legislation, competition, state of the money market, progress in the manufacture of machinery, and so on indefinitely. The point of all this is that when one comes to figuring probable costs and results in any mining or metallurgical enterprise, the task is not as simple as might appear. The estimate never includes more than a part of all the factors; but whether the estimator is conscious or unconscious of their existence, they are all the same in the actual result.

TO RETURN to the matter of low costs: Taking the concrete example of the production of gold by the two simplest methods, hydraulic placer mining and the working of free-milling ores, some surprisingly low figures are arrived at. In the famous case of the North Bloomfield hydraulic mine, of Nevada county, California, where an immense mass of low-grade top gravel was piped off in a long run, it was found that a yield of two cents per cubic yard covered all expenses. If gravel were rated by weight instead of by measurement, this would mean that it was handled at a little over a cent a ton. Such a statement may seem incredible to those not familiar with the possibilities of hydraulic mining on the largest scale, under the greatest advantages and with the best skill; but it is a matter of record. Now to estimate on this basis for an ordinary placer mine would be absurd. There are not so very many records of success where the gravel ran lower than ten cents a yard. Some mines of large deposits, with a plentiful and cheap water supply, ample dump room, and a fairly long working season, have paid well on lower than ten-cent gravel; still, in projecting new hydraulic mining enterprises, it is always well to allow a wide margin above expectations founded on the historic records.

THERE are many other kinds of placer mining besides the hydraulic method, such as river mining, shovel-sluicing, "booming," etc., most of which are as obsolete as the old pan and rocker, and which, being on a small scale individually, are much more expensive than hydraulic mining. Then there are other kinds of workings which form an intermediate link between placer mining and quartz mining, such as drift mining, under barren gravel or lava cap, cement mining, pocket mining, sluicing of decomposed vein-croppings, etc. Some of these cost less, others more, than regular vein-mining. The experience as to cost is of little value, for the conditions are too irregular and uncertain. Finally we come to those vein-mines which are worked by open cut, as were some of the great gold mines of the Black Hills district of South Dakota and elsewhere.

PERHAPS the best example of a great low-grade gold mine is furnished by the Treadwell, in Alaska, where very careful accounts are kept. In this case there are the disadvantages of remoteness and climate; otherwise the circumstances are peculiarly favorable. Allusion has been made already in this Department to the low costs at this mine, but it may be interesting to quote further details:

The Treadwell is practically an open quarry. The report of the Alaska-Treadwell Company for the year ending May 1, 1893, shows that the quantity of ore crushed was 237,235 tons, yielding an average of $2.13 in free gold. There were 4276 tons of sulphurets saved by concentration and 4584 tons treated, giving an average of $41.28 per ton. The average for all the ore treated, including yield from sulphurets, was $2.94 per ton. The cost of work last year is given very fully in the report. Mining (237,235 tons) cost for labor, 39.60 cents; supplies, 20.74 cents; total, 60.34 cents per ton. Milling (237,235 tons) cost for labor, 18.37 cents; supplies, 25.60 cents; total, 43.97 cents per ton. Chlorinating concentrates (4584 tons) cost for labor, $5.3432; supplies, $3.649; total, $8.9922 per ton. Averaging all costs on the ore mined, the result was: Mining, $0.60; milling and concentrating, $0.44; chlorination, $0.17; general expenses at mine, $0.07; San Francisco office, $0.02; bullion charges (freight, insurance, etc.), $0.05; total, $1.35 per ton.

LOW as the foregoing figures go, they do not yet reach the phenomenal record made by the Spanish mine, Nevada county, California, four or five years ago. The following description is taken from the *Mining and Scientific Press*, of San Francisco:

At this mine the vein averages ninety feet. The hanging wall is a slate, soft, shaly, and not well defined. The true vein is on the footwall and consists of solid quartz, four feet thick. It does not pay for working. The pay is found on the hanging wall side, which contains many veinlets and streaks of ferruginous quartz carrying gold. Where no quartz is to be found there is no pay. The slate on this, the west, side is talcose. The main tunnel was in 1200 feet. The vertical distance from the surface to the end of the main tunnel was 350 feet.

By connecting the tunnel with a surface excavation, the ore was run out through the tunnel in cars by gravity, the empty cars being brought back by mules. The material treated, being soft, was passed through roller mills. In a twenty-eight days' run, during which 3443 tons were handled and $3138.55 extracted, the cost of mining was $0.346 per ton; of milling, and other expenses, $0.239 per ton; total, $0.585 per ton. The ore only yielded a trifle over ninety-one cents a ton, yet a profit of $0.32 per ton resulted, giving a percentage of profit of 35.8 per cent. of the total yield. In other months the mine had made almost as low records. This case is especially noteworthy on account of the comparatively small scale of operations.

It would be useless, even were this the place, to quote further examples of the economy reached in the gold industry. The foregoing are sufficiently striking to dispel any notion that close figuring does not obtain in mining. But, lest it might be imagined that gold-mining furnishes an exceptional instance of economy, it may be added that equally instructive figures could be adduced from other lines of mining, notably in the mining of coal, iron ore, and copper ore. It is worth remembering that valuable metals are obtained, and profitably, from material handled at a cost often far below that of moving building sand, road gravel, or the cheapest and bulkiest substances worth handling at all. Mining is also often done more cheaply than the grading of roads and streets, excavating for sewers and pipes in cities, making railway cuts and tunnels, building jetties, or any other of the analogous operations carried on in thickly-settled communities. Another lesson to be drawn from the two cases of the Treadwell and the Spanish records just quoted is that the economy gained is equally as much in the metallurgical treatment as in the mining proper. This, too, holds with the making of coke and the extraction of metallic iron and copper, and indeed all along the line of metallurgical processes. But, in brief, the two main conclusions to be kept in mind are: (1) It is not safe to base estimates on phenomenal records, and (2) on the other hand it is all nonsense for the "process men" to claim that they are going to revolutionize present matters in a hurry.

While on the subject of mine and reduction-works records it is proper to call attention to the method in which the accounts are kept and the averages derived. There is a great discrepancy between the systems followed at different establishments of the same class, so that comparisons become difficult. It is a matter of some uncertainty under which head a given item is to be charged, so when a company operates not only a mine but also a mill or smelter, or perhaps a number of separate plants all coming under the head of one establishment, or if separated still under one corporation, it makes considerable difference whether certain items (like haulage between mine and mill, for instance) are charged to one department or another, and how the general expenses are to be distributed. When a report is given in minute detail, as a few of our superintendents and secretaries take pride in doing, these items can be redistributed for comparative study. Unfortunately, the majority of company reports are published in such shape that they are almost unintelligible, and if they give the main things—that is, the true profit and loss for the year, condition and prospects of the property, etc.,—they may satisfy the average shareholder, but they are worthless from the technical standpoint. Indeed it is not so easy to learn from many reports even what the real commercial results are, any more than it is to understand the too commonly mystifying reports of banks, railways or insurance companies. The great fault, however, with most mining reports is in the numerous sins of omission. They do not allow for interest on invested capital and depreciation of plant, or set aside a sinking fund to extinguish investment. These matters should appear in the general financial statement. The general expenses, as office, commissions, freights, insurance, etc., form a group of items which certainly ought to be taken into account when figuring up the average cost per unit of product, though this is seldom done. Superintendents naturally like to make the best showing for the technical administration, and it is always a temptation to omit on this side every charge possible. For instance, taking the case of short runs or campaigns, it is a common thing to avoid charging up wear and tear, replacements of parts of machinery, and use of supplies already on hand. This practice may give an exceptionally good showing for a short period, but has to be made up in the end. An opposite case often occurs in the statements for metallurgical works, when a total clean-up has not been made. The points here mentioned are only a few of the perplexities surrounding the question of mine accounts. There is room for a big book on the subject. It is well that some of the technical schools are taking the matter up, and provide some instruction in this line.

An institution which has undoubtedly done much good, and which, within its proper sphere and under evident limitations, is to be highly commended, is a "correspondence school of mines" established in Pennsylvania by the enterprise and in connection with the management of an excellent technical journal, the *Colliery Engineer* (Scranton). The purpose of this school is to furnish a mining educacation—that is, so far as this can be imparted through books, essays, questions, and written examinations—to students at their own homes, at low cost and without the necessity of withdrawing their efforts and time from paid work, if they are engaged in any. It therefore fills a "long-felt want," in offering to working miners and young students some of the advantages of the regular scientific schools which they would otherwise be unable to enjoy. In its own field, then, it has been doing good work; and the writer, fully appreciating its merits, has had frequent occasion to recommend it to numerous inquirers who have applied for information in regard to means of getting a moderate technical education and who seemed unable to devote the time and money necessary in pursuing a full course at any of the regular institutions. It is with surprise, therefore, that this otherwise meritorious institution is found issuing the following advertisement:

MINING and Prospecting Taught by Mail, also Mechanical Drawing, Mechanics, Arithmetic, etc. To begin, students only need know how to read and write. Diplomas awarded. Low prices. * * *

Now, mechanics and arithmetic can certainly be taught "by mail" or by the study of selected text-books. So also can a number of other branches which might be enumerated. But it is assuming altogether too much to claim that "mining" (taking the word in a broad sense and as it is usually understood) can be taught by mail, by essays, lectures, or books. All that the best-manned and best-equipped schools can do is to give the student some idea of the general principles underlying methods of opening and working mines, and they generally try to supplement this sort of information by visits to mines and works where the things talked about are actually done—in short, by summer schools temporarily established in mining districts. It is quite possible to explain in a book why a shaft should be sunk in the hanging-wall side of a vein, why an adit would be preferable to a shaft under certain conditions of topography, why overhead stoping is better than underhand, why the long-wall method is better in some places than pillar-and-stall, why one style of timbering should be chosen rather than another, the quantity, pressure and velocity of air theoretically required in a given working, and so on. The young man who has been well grounded in these and similar fundamental propositions has an undeniable advantage at the outset over one who has not, but if he were turned loose to run a big mine without experience and with no further guide than his books, he would very soon find himself at a loss and, if wise, would fall back on the advice of his foreman. Fortunately the responsibility of managing a mine is not now often placed upon the shoulders of the young graduate of any kind of school. This of course applies more or less to all mining schools. The point is that if real mining cannot be taught by the best-equipped schools, still less can it be taught without their advantages.

Prospecting is another thing that is to be taught by correspondence. This is a serio-comic proposition, and only the innocent naïveté of the idea shields it from censure. Without knowing exactly how this accomplishment is to be imparted, it may be assumed to be on the lines laid down in the books. For instance, the hopeful prospector in search of metalliferous deposits starts out with the prescribed equipment of geological hammer, note-book, lens, sample-bags, pick, shovel, and pan,—all of which he couldn't comfortably carry a mile on level ground. He begins at the mouth of a gulch and follows the drainage line upward. He picks up all promising or unusual pebbles, cracks open the quartz boulders, pans out the sands, and generally looks for float or colors. These of course he finds—in the books. Then he keeps on upward till his "indications" give out. At this point he knows that his lode, or whatever it may be, must be to the right or left of him, or at the head of the gulch if he is at the end of it. So he climbs up first one side and then the other of the cañon he is prospecting, looking for float until it ceases, then for croppings, or if there are none, he begins a series of trenches to uncover a blind vein. Ultimately he finds it—according to the books. Next he proceeds to locate and develop his discovery, as instructed. All this is plain sailing—or would be if things turned out as they ought to. But in real existence they do not. The amateur prospector would find himself about as helpless as the amateur geologist undertaking field work for the first time, and expecting to find actual sections marked off in nature just like the diagrams of the text-books.

TO prospect successfully requires either that rough practical experience and intuition possessed by real prospectors, or a part of this supplemented by a thorough mineralogical training, or (as often happens) sheer blind luck. Most decidedly it is not to be learned by "correspondence." And speaking of mineralogy, how is one to learn to identify minerals without access to systematic collections and without a course in blow-piping? To know by rote the crystallographic form, specific gravity, hardness, cleavage, luster, color, fusibility, etc., of minerals is of little avail without practice, and pretty extensive practice at that,—certainly not without seeing and handling the things in question. The determination of ore minerals and substances of economic value may be self-taught (with disadvantages), if the proper books and material are accessible. So might the fire-assay, the wet qualitative tests, the wet quantitative assay, and colorimetric and volumetric assays, provided one had a suitable laboratory at hand. So too might surveying be taught, if one had the instruments and tables. And so also mechanical drawing and many other things. But all of these can be more rapidly and accurately acquired by being shown than by reading about them.

WHEN it comes to metallurgy the correspondence system will find itself in a worse plight than ever. Suppose it is a question of concentrating a given ore or of adjusting a given type of machine. The books are full of researches in the higher mathematics bearing upon points of this sort, all of which are useful to the mechanical and metallurgical engineer who desires to perfect himself in his profession, but they would be of about as much assistance to the young aspirant to metallurgic honors and responsibility as a course in thermodynamics would be to a locomotive fireman. When brought face to face with practical problems, such as occur in actual work, he who relies upon what is called "book knowledge" alone, whether acquired through a correspondence school or at any regular technical institution, will discover to his sorrow that there is still a good deal more to find out.

NOW, to return to our advertisement, which declares that "mining and prospecting" can be taught "by mail," and that only a knowledge of how to read and write is needed to begin with. It is something like going after reed-birds with a Gatling gun, perhaps, to be captious about the wording of an advertisement and to find fault with an admittedly meritorious undertaking merely because of a slip. But there is a serious side to the matter. While every mining man will pass over with a smile the assumption that mining and prospecting can be taught by mail (or indeed in any school), such a claim is likely to mislead some, and, though it may bring in a few more fees, it will not in the long run redound to the credit of this original and otherwise commendable scheme.

MACHINE SHOP PRACTICE

Conducted by Albert D. Pentz.

THERE should be in every city a local society or club of mechanical engineers who get together periodically and discuss professional questions. It will be observed that I do not say that they shall get together for the purpose of discussing mechanical questions, but that they shall actually discuss them. The trouble with mechanical clubs generally is that the right kind of men do not discuss the right kind of questions; in fact, they are not thought of, neither the right men nor the right questions. Ordinarily the questions most discussed in societies managed by professional men are those pertaining to the data and the mathematics of arts already established on a firm basis. Now, while I have no disposition to detract from the value of the formulation of data of assistance to any art, such formulation is of more direct interest to the teachers and pupils of schools than to those who are experimenting with and developing other arts yet in incipiency. The cry for help comes not from strong and healthy arts that already are conquering the earth, but from those now in the travail of invention. Instruction in mechanical movements is what is wanted. I do not mean the mass of kinematics theoretically taught in course of ordinary training, but specific instruction by men who know of their own experience which is the most appropriate motion with which to operate a particular new element in a new art. In some cases it is doubtful to the inexperienced whether a particular thrust should be performed by a lever, a screw, or a rod driven by an eccentric. There are men, however, who have had experience in arts analogous to every new art or in movements similar to every new movement, and these men will have discovered which kind of movement is best in that particular place. Hence, in each city, if all the engineers who do creative work should meet and discuss their actual needs, asking and giving in the spirit of progress, it is certain that interest in such meetings would be general and that he who gave would be as much benefited as he who received. Again, it is very improbable that any one can always be either the giver or the receiver.

A GREAT fault to be found in some societies is that in each a coterie representing a small but influential faction obtains control of the management and rules the society. In such cases many vital questions with which such a coterie may not be in sympathy will be pigeon-holed, though there be papers of great value to such questions offered for their discussion. On the other hand, to subjects congenial to the coterie, and to papers presented by those *in persona grata*, there is an enthusiastic and effusive welcome offered, though perhaps such papers may treat of nothing new under the sun. When this fault exists, it is incurable, except at the cost of cutting away the predominating faction; it grows stronger on abuses. No criticism can be offered that does not entail a punishment out of all proportion to its importance. Neither can members who offend by offering criticism ever hope for distinction within these societies. Personal ambition, if permitted to take root and grow within a society, will ruin that society by absorbing its vitality. And it will ruin the society, or try to, if it be removed.

DURING an afternoon spent with that fine engineer, C. W. Hunt, he told two stories illustrative of as many vital points in machine design. The first was of grand old John Fritz, to show how slow and tortuous is the road to perfect operation in a new device. A friend of John Fritz, also an engineer, asked him if all or any of his grand improvements worked at once as originally designed. John Fritz's answer was: "When we get the idea of a device which we think will work, we call a council of all those who can assist or who are to carry on the work, and we talk it over. Then we have rough sketches of it made, and we talk it over again. Then we have working drawings made and we talk it over again. Then these drawings are taken into the shop and the device is made. Then when it is finished, the boys come and ask me to go and look at it. Then I ask them if it is all made like the drawings, and they will probably say it is. Then I ask them if it works properly, and perhaps they will say 'yes.' And then I will tell them, 'Now we will go down into the shop and see why it doesn't work.'"

THE other story is of an engineer who operated from data only, and who built a bridge with a long span, getting his every element from theoretical sources. The very first freight-train that crossed that bridge went down, taking the bridge with it. The engineer could not believe that his bridge had collapsed, as he had calculated with great care every strain it could receive. So he went out to see if the fault did not lie in material or workmanship. Neither of these, however, showed a defect, so he retired to his closet and went again over his calculations. It was toward the middle of the second afternoon when he emerged from his researches, and as he passed out into the open air one of his assistants heard him mutter:

"Damn that decimal point."

What that engineer needed was the trained eye of practical experience that usually is able to see whether a section, an arch, or a lever is strong enough. An experienced man should be the complement of the mathematician in every calculation of any consequence. Where but one engineer is to be employed, select the practical man, or better, one who is both the one and the other.

THE most economical cross-section for resisting torsion is, of course, the hollow cylinder. But an economical lever that receives no torsional strain, and delivers none, should have a cross-section that may be described as an ellipsoid. I get this section thus: After the length of the section and its width are determined, I draw a circular arc that has a chord 10 per cent. longer than the major axis of the desired section, with a versed sine equal to just half its minor axis. Then, with another small circular arc joining the larger arc to the length to which the section is limited, the thin edge of the section is completed. Where the strain is only on the plane occupied by the major axis of this section, and where this major axis is a plane at right angle to the fulcrum of the lever, this seems to be a most satisfactory form. Where the strain in a lever is both torsional and flexional, the section ought to be an ellipse, hollow if practicable with the major axis arranged to oppose the greater strain.

CUTTING-TOOLS on metals do not always wear to the extent they are supposed to wear. Ordinarily they are burned by too great a speed. It may not be amiss here to explain what this burn is. When two pieces of similar metal are moved, the one upon the other, while held together with considerable pressure and without a lubricant, they soon will weld together at the point undergoing the greatest strain and friction. Thus, an iron shaft in an iron box becomes cut or galled, and thus the point of a steel tool when cutting iron is often taken away after doing but little work. Dissimilar metals do not burn each other to so great an extent. When an iron shaft is contained in a box of bronze, one metal being no harder than the other, they seldom or never unite; therefore a steel tool can cut brass or hard bronze at very high speeds. In planing cast-steel it is questionable whether a speed above twelve feet per minute is safe, but in cast-iron, where graphite is present in the iron, it lubricates the tool and sometimes it is safe to cut twenty feet each minute through the material.

In the interval after one discoverer of perpetual motion is silenced, and before another asserts himself, the inventors of processes and means to harden copper have their innings. I think it was Wendell Phillips who, in his lecture on Lost Arts, asserted that copper could be hardened and made to cut like steel, and that it had been found so hardened in the ruins of Egypt and ancient Mexico. Possibly this is so, but Humboldt found that a Mexican specimen of hard copper was composed of .94 copper and .06 tin. Wilkinson also found about the same proportion in an Egyptian sample, with the addition of a trace of iron. Now tin always makes copper harder and there is no evidence of other means to harden it, and I do not believe that a piece of pure copper can be made as hard as steel is made by any process, new or ancient. I will gladly pay a good price for a very small specimen of pure copper made so hard that it can cut iron as steel does without melting the copper to harden it.

We have a rope-drive working under the following conditions: Rope about 1000 feet long, 1⅛ inches thick, furnishing about 50 horse-power to six floors, one above another. This rope runs on about thirty sheaves, thirty-six inches in diameter, and part of the way the rope is exposed to the weather. The first rope was used up in five months. It was dressed once in two weeks with a compound of tallow and graphite. It broke three times before it was discarded, and at each break a new piece of rope was inserted. The present rope has been used about five months. It is a much looser spun rope, composed of but three strands. The other had four strands and a core. This rope is and has been treated every two weeks to about two quarts of boiled linseed-oil, dripped one drop at a time upon one of the sheaves which is uncovered on top, taking perhaps three days to drip it on. The rope covers the bottom of the sheave and absorbs the oil. If oil be administered too fast, it will be thrown off and wasted. It now shows but little wear on the outside and none within. It is as firm as oak, yet sufficiently flexible and reminds me of hard sole-leather. The rope travels at least 1800 feet per minute when at work.

Ordinary dough is often used by die-makers to remove filings and other kinds of dust from cavities that are being operated in. This substance could be used advantageously in many places by makers of fine tools. If the dough is of the proper consistency, it will hold together strongly and work well for days. The dirt it absorbs does not impair its efficiency and it is only rendered useless by becoming hard or sour. If the subject were studied, I presume that some liquid besides water—perhaps glycerin—might be found to keep the dough soft and prevent its turning sour.

A substance called "corn-pith" is also used in watch-factories for about the same purpose as that indicated for dough. I presume from the name that it is the inner part of the stalk of maize. The pith of elder, I think, would serve the same purpose.

In a factory the man who works for a personal record is a hindrance. Suppose that he is running an engine, and that he is trying to make a phenomenal record for economical results; he wants to produce more horse-power with less coal. He tunes up his engine and studies his fires so carefully that he succeeds about four hours out of five. But in the other hour, when the polishing-room is pushing its work, the circular saws are running, and the elevators are lifting heavy loads, the engine will slow up about 10 per cent. Thus while the coal-pile is saved to the extent of perhaps fifty cents, the factory suffers a loss of fifty dollars.

Catalogues may be indexed in this manner: When one arrives it either is numbered at once by having the next higher number pasted to it, or it is put with others, until a month's receipts are in, and then all are numbered together and placed in drawers holding twenty-five or more. These drawers also are numbered. When a drawer is full—or perhaps upon the receipt of each catalogue—they are searched through carefully and every subject in every catalogue is noted on a separate card. Thus we have perhaps one hundred cards headed "Engine Lathes," each referring to a different catalogue and specifying that catalogue by drawer and number. When a catalogue is received from a concern whose previous editions are in hand, it goes in just the same and takes the next higher number. The older ones, however, remain in the drawers and their cards remain in the index-case. This permits us to trace obsolete articles, and to follow changes. One prominent concern changes all the numbers on its milling machines and we thus can tell what was the old number of a present new number. These cards are kept in card-cases such as are used for cataloguing libraries. It takes not more than five minutes to find any subject and all there is about it in every catalogue in the office. Separate cards may be written for each catalogue and kept in a separate compartment as "addresses."

The data also,—for modern catalogues contain a great deal of valuable scientific data,—are indexed in the same manner. To this may be added current technical literature, indexing the really valuable articles by this same convenient system.

FOUNDRY-MEN are really behind the times, for if machine-shop people were to offer work as inferior as that of many molders, American mechanical superiority would no longer exist. That two castings from the same pattern, made by the same man, should vary in weight 10 per cent., is a mechanical crime that should be punishable. It would be punishable if there were enough foundries in existence where castings are made "true to pattern," and the punishment would be entire loss of trade.

I AM obliged to differ with Professor Torrey, who wrote in the Magazine last month on mechanical instruction in technical schools. I admit that many graduates of technical schools "aspire to positions of responsibility and trust in manufacturing establishments." I admit further that frequently they attain these positions. But do they fill them? Can any man direct the work of manufacturing efficiently who does not know how to direct the operations in detail? As well might we expect a yachtsman to become expert by viewing races from an excursion steamer. We do not need to discuss this question in theory. We all know how it actually operates in practice,—that until the graduate gets real practice on actual commercial work, he has no value in mechanical positions involving trust or responsibility. Clerical positions, on the other hand, can be filled easily by persons having no technical education whatever.

IN experimenting on new devices it often happens that a very elaborate or a very crooked piece of metal is required. If such a piece were to be forged, the cost would be frightful. If it should be cut out of the solid stock, the expense would be greater still. The cost of a regular pattern could not be thought of; besides, such things generally are of such shape that they cannot be drawn from the sand in a two-part flask, and they frequently have to be cored in the most unpractical places. When such pieces are required in my own work, I sometimes make them of wax. Any kind of wax that will hold together and melt at a low temperature will do. I place the cores, having suitable extending supports, in position where they are needed, and hold them there temporarily on wires, which wires are to be withdrawn from the mold before the piece is cast. Then the shape which is needed is modeled about the cores by hand from the wax made plastic by warmth. When the desired shape is finished it is molded, with no partings, in a single flask. It must have the usual gates and vents, however, so that when the mold is heated in a core-oven, the wax will run out into a pan. Usually after such a mold is heated it is best to turn it over to empty any pockets there may be in them of the wax, so that it may find its way out through the vents. One skilled in such matters can make a pattern such as this much quicker than he can make a drawing of it. Of course this process destroys the pattern, which in machine-manufacture is often an undesirable contingency. In art castings, however, as in the French statuettes, it is desirable that one shall not be exactly the copy of another. So this method with certainty secures the result that each is itself a work of art, and unlike any other in existence. I have seen Japanese workmen "sweep" the core for a bell to weigh two hundred pounds or more, then sweep wax on that core to make the shell of the bell of the thickness desired. On this wax the designs and ornaments were engraved, all with the simplest tools, a few pieces of wood, and a graver. Then the whole is covered with loam. After that the wax is melted out, saved, and a casting made which always is a work of fine art.

I HAVE a friend who, some time ago, experimented in incandescent electric lamps and became quite an expert glass-blower. Now when he wants to make patterns for castings, he takes a tube of glass and blows it into the desired shape, and it must be a complicated contrivance which will not submit to his fashioning.

THERE really is no good chuck made for drills used in drill presses. They are all unreliable after a short usage and the unreliability is generally in the element which grips the drill tightly and makes it run true. One kind wears out of truth on the shoulder which locates the jaw-screws. Another wears out on a worm and gear. In another the angular sides and edges soon lose the centering precision, if it ever has it, and so on. It seems to me that some one should be able to devise a strong and durable self-centering drill-chuck, or so improve one of those now made that it shall be satisfactory for one year at least.

JUST how far a belt dressing is good and how far it is bad, is an unsettled question. A certain quantity of a suitable oil preserves leather. Too much will destroy it. I do not think that, on the whole, oils improve the tractive power of a belt. If they do it, it is at the expense of the motive power at its source. As a filling to preserve the leather, degras is probably the better of many, but neat's-foot oil is good, so also is castor-oil.

IT seems almost too late to advocate the placing of friction clutches on the main lines of shafting in every factory. But when so few are found that have these conveniences, the necessity is apparent. Do not all shop-owners know that a few short stoppages of the engine cost more than a whole suit of clutches? Suppose, for instance, that in a factory employing one thousand hands to operate machines an accident occurs. Perhaps a belt catches on the main shaft and wraps, so that it requires a stoppage of fifteen minutes to get it off. At an average of twenty cents per hour per operative, this stop costs fifty dollars. But in a shop where friction clutches are prevalent, there need be but fifty men idle, at a cost of two dollars and a half.

A FEW years ago, having to use lard-oil for lubricating purposes, and finding it to gum on cast-iron surfaces so much as to be detrimental, and imagining that the gumming quality in the oil was gelatine, I filtered a quantity of it through tannic acid. This certainly improved it, but was expensive. Now lard-oil is without doubt one of the best lubricating oils known, but it will get gummy with the conditions above named, and I have looked for many years for a means to rid it of its sole evil element. Recently, having occasion to experiment with an oil-filter, I noticed that one of the printed directions is aimed toward the fact that too much heat in the water with which this filter is charged will coagulate lard-oils. I find this to be a fact and, further, that the coagulated particles will precipitate, and after a few days be found at the bottom of the oil. The oil then can be poured off, and it seems to have parted with its gummy quality. If others will try this, and if they find the same result, an improved lard-oil is possible, and the improvement will be a cheap one in respect to first cost.

CURRENT TECHNICAL LITERATURE

THE THEORY AND PRACTICE OF MODERN FRAMED Structures. Designed for the use of schools and for engineers in professional practice. By J. B. Johnson, C. E., Professor of civil engineering, Washington University, C. W. Bryan, C. E., and F. E. Turneaure, C. E., Professor of bridge and Hydraulic engineering, University of Wisconsin. New York: Wiley & Sons. [Cloth. 4to. 508 p. $10.]

SINCE the time of Professor Rankin, the scheme of text-book preparation has undergone a great change. Many writers, while not agreeing with the world-renowned preface of Mr. John C. Trautwein, that the works of many of the great writers are "little more than striking instances of how completely the most simple facts may be buried among heaps of mathematical rubbish," still believe that purely theoretical demonstrations of many of the truths that we use in daily life should be relegated to special books, and this is a case in point. The authors state in their preface, "this work is something of a compendium, a text-book, and a designer's handbook, all in one." We must therefore judge the value of the work not only by its filling a place, but also by the success with which the writers have attained their avowed object.

The book is divided into two parts, with an appendix, the different chapters being prepared by different authors, the intention evidently being to have each writer treat the matter with which he is most familiar in order to obtain the best results. As a whole, the book may be said to be a decided success, not alone for what it is, but also for what it indicates, and especially because it shows a recognition on the part of the instructors of the necessity of equipping the student with practical knowledge at the very outset. In addition, the treatment throughout is happy and explicit. The information given is as nearly as possible up to date, and it is therefore a work which should be found in every engineer's library. Some of us may feel that the analytical method is given too much importance as compared with the graphical, but that is a matter of detail. We may also feel that it would have been better to have made two volumes, with a more distinctive separation between the text-book and the handbook, and that quite a considerable portion of the work could with advantage have been furnished to the student in the form of lectures, but these too are details.

The chapter scheme is as follows: Part I.—(1) Definitions and historical development; (2) application of the laws of equilibrium to framed structures; (3) analysis of roof-trusses; (4) bridge-trusses—analysis for uniform loads; (5) bridge-trusses—analysis for wheel loads; (6) conventional methods for treating loads; (7) lateral truss systems; (8) fundamental relations in the theory of beams; (9) column formulæ; (10) combined direct and bending stresses; (11) suspension bridges; (12) swinging bridges; (13) cantilevers; (14) metal arches; (15) deflection. Part II.—(16) Determining conditions of the styles of structures; (17) design of individual members; (18) details of construction; (19) plate girders; (20) roof-trusses; (21) railway bridges; (22) highway bridges; (23) detail of Howe truss-bridge; (24) detail of swinging bridges; (25) trestles; (26) esthetic design; (27) stand-pipes; (28) iron and steel tall building construction; (29) Iron and steel mill-building construction.

Every chapter is good, showing the results of earnest thought and hard work, still in places it would seem as though an improvement could be made; thus it is questionable whether, in making the stress diagrams, it would not have been better to have marked the lines *plus* and *minus* rather than to attempt to indicate the character of the stress by the weight of the line, since in draughting it is easier to write a sign than to draw a line over two or three times to make it wide enough; and especially so when an exceedingly sharp pencil is used in order to make the closures as accurate as possible.

Chapter VIII should have been nearer the front of the book. The subject matter is excellent, and the tables showing the relation between M, I, and R, are good; but it seems rather a pity that graphical methods of determining M for a variety of loads, are not given. Chapter IX does not go so far perhaps as it might into a discussion of the relations between the various members. Chapter XIII is good, although the maximum and minimum proportions have not been indicated and might have been with advantage.

Chapter XIV contains a certain amount of mental gymnastics evolved in connection with the arch fixed at the springing lines which might as well be omitted, since it is highly probable that no one would ever build an arch with fixed ends. It would have been well, since beams and girders have been treated, to have discussed their deflections. The fact that the principles are the same, and that the result can be taken out by careful study, is perhaps the reason it was not done. The table given on page 224 is very excellent. The results of tests of rivetting, given on pages 263–265 are very good. The conventional rivetting signs given on page 267 are substantially those originally devised by Mr. Frank C. Osborn, M. Am. Soc. C. E., and although extensively adopted by the bridge-builders throughout the country, should be credited to him in a standard work.

In either Chapter VIII, or the preceding one, attention should have been called in the designing of compressions members at the end pins, to the necessity of transferring the strains over the member more fully, as was very excellently brought out in a paper by Mr. Thomas H. Johnson presented before the Engineers' Society of Western Pennsylvania, reported in the *Engineering Record* for June 17, 1893.

The treatment of roof-trusses inclines toward that of large roofs, and it would have been well for the writer to have noted the fact that it is very desirable in small roof-trusses to proportion the purlins or upper members so that at least two men could have been carried on their center without injurious deflection so as to make it possible to paint the truss and its covering without erecting a scaffold for the purpose. The treatment of the purlins and the loss in strength of section due to the inclination of the purlin might also have been noted.

Chapter XXVIII is not only very good, but very much needed on account of the tendency at present to use cast-iron columns in building construction. It is well to remark, however, that office buildings, to which this chapter most generally applies, are, by reason of their character, subject to well defined laws which quite closely limit the general details of design, and it would have added much to the value of the work and to the meager literature on the subject, to have had a discussion as to the limiting conditions of height as compared with breadth, the deflection of skeleton construction under wind pressures, the proper amount of wind pressure to provide for, and the most economical spacing of beams, girders and columns. In the examples given, no weight is given to the column spacing. Mention should also have been made in the designing of floor-beams of the fact that, in order to keep the deflection within safe limits, it is desirable to have the depth of the beam one-twentieth of the span.

The method of calculating, as given, seems to be rather putting the cart before the horse; less work would be required and better results obtained if the loads were traced from the floor blocks to the beams, then to the girders, and from the girders to the columns, increasing the safe fiber strains in a regular ratio up to the columns and decreasing the load at the columns in a regular ratio. We know that it is quite likely that the floors will be loaded in isolated cases to 500 pounds per square foot, that an office might easily have 100 pounds per square foot of live load in it, while the average throughout the building would probably be about 25 pounds, and by taking ½ to ⅔ of the girder reactions for the column loads, we should approach very closely to exact conditions and would know exactly the amount of eccentric loading to which the column was subjected.

The foundation methods explained, while excellent, and a decided advance on the first of Chicago steel cribs, are still wasteful in their use of metal, and it would have been well to have called attention to the use of girders for spreading members. In figuring the areas required to carry the loads sufficient experience has not yet been gained to state positively that no live loads should be allowed for, and it would have been well to have left this open. Lack of more detail treatment of these points is probably due to the limitations imposed by the scope of the work, since Mr. Purdy has done most excellent work in this line, and the above points would naturally suggest themselves to him as requiring it.

The closing chapters and appendices are most excellent and will be of much value, and the work as a whole marks a decided advance in technical literature, and is to be much commended, such points as are noted being really of trifling weight as compared with the whole.

George Hill.

Lectures on Sanitary Law. By A. Wynter Blyth, M. R. C. S., L. S. A., Fellow of the Institute of Chemistry; Barrister-at-Law of Lincoln's Inn; Professor of Hygiene, College of State Medicine. London and New York: Macmillan & Co. 1893. [Cloth, 8vo, 287 p. 8*s*. 6*d*., net.]

One of the earliest subjects of legislation, even in the rude beginnings of civilization, was the preservation of public health. As science developed, it was demonstrated that many of the ancient ordinances had a solid basis of reason. In modern times, England, France, Germany, and the United States have done much by legislative enactment to promote true methods of sanitation, and each of these countries has a large and increasing literature upon all that pertains to sanitation. Periodicals devoted to sanitation and to sanitary engineering, with a constantly growing influence, have taken a permanent place among modern technical publications. Schools of technology have found it necessary to afford facilities for instruction in sanitary science as a special branch of study. The results of all this are apparent. For example, during two successive summers Asiatic cholera has threatened to invade the United States, yet, through a more adequate knowledge of its character and causes than was possessed in former epidemics of this dreadful disease, the energy and watchfulness of able health officers have been successful in preventing its gaining a foothold.

Fifty years ago Americans were horrified by the picture of the frightfully unsanitary condition of the tenements of the poorer classes in England, and of shops, factories, and mines in that country, as vividly portrayed in Lester's "Glory and Shame of England." Much has been done since that time by legislative enactment toward remedying the then existing evils. Sanitary laws have multiplied, and nearly everything essential to public health has been made the subject of scrutiny by able commissions with a view to intelligent legislation for the abatement of public nuisances, the prevention of excessive labor exactions, the proper ventilation of mines and factories, limitations of age of children with reference to their employment in certain kinds of labor, and the protection of rivers from pollution by the discharge of noxious and offensive matters into their waters.

The extent and scope of sanitary legislation in England will be surprising to many people who will peruse with interest the excellent book before us. It comprises twelve lectures on sanitary law delivered by Professor Blyth as part of a regular course of instruction in sanitarv science in the College of State Medicine in England. The first lecture is devoted to a description of the administrative sanitary districts and sanitary authorities, urban and rural, in England, Wales, Scotland, and Ireland, with legal definitions of what constitutes an owner, a house, a building, a drain, a sewer, a canal, and a canal-boat. The second lecture deals with the subject of nuisances, which are divided into "common," "private," and "mixed" as statutory nuisances under the Public Health acts; with references to leading cases that have been decided in the courts where abatement of nuisances has been sought by legal processes. An interesting feature of this lecture is its able discussion of nuisances arising from accumulations of unsanitary or offensive matters, overcrowding in dwellings and factories, uncleanliness and imperfect ventilation in factories and workshops, smoke, and the neglect to properly fence in abandoned shafts of coal-mines, or otherwise to provide that they shall be rendered safe against possible injury to life and limb. The subjects of sewerage, drainage, and water-supply form the subject matter of the third and fourth lectures. The fifth, sixth, and seventh lectures relate to sanitary appliances, regulations, by-laws, and statutory provisions with regard to the prevention of disease. The eighth, ninth, and tenth lectures respectively treat of port sanitary law, the "Housing of the Working-Classes act" (1890), and sanitary law as it relates to canal-boats. Two lectures on Metropolitan sanitary law complete the course.

An appendix comprises specimens of by-laws in force in the metropolis as to certain offensive trades, as tripe-boiling. the knacker's trade, catgut-making, gut-scraping, the manufacture of glue and size, blood-drying, fat-melting, and the manufacture of animal charcoal. The appendix also contains proposed by-laws under the "Public Health (London) act," this act providing for the regulation of the sale of food, drugs, etc. The work is especially well indexed.

To those who wish to become familiar with English sanitary law the book will furnish in compressed form a very comprehensive view of it. To sanitary engineers the book is also recommended, especially to those who are liable to be called upon as expert witnesses in litigations relating to pollution of water-supply, and the effects of certain manufacturing industries upon the health of surrounding population, and also to municipal authorities as a guide to procedure in securing general sanitation of cities and towns, which are questions of moment.

LEICESTER ALLEN.

THE TRANSITION CURVE BY OFFSETS AND BY DEFLECTION ANGLES. By C. L. Crandall, C. E., Associate Professor Cornell University. New York: John Wiley & Sons. [Cloth. 16mo. 64 p. $1.50.]

WHILE this book is intended primarily for the use of civil engineering students, the author believes that the complete set of tables given by him will render the methods developed by him for the true transition curve at least as rapid and convenient in use in the field as the more restricted ones now in use. .

THE JOURNAL OF THE IRON AND STEEL INSTITUTE. Edited by Bennett H. Brough. Vol. XLIII. No. 1, 1893. London and New York. [Cloth. 8vo. 476 p.]

THIS volume is divided into two sections. The first contains the presidential address, which deals with some of the developments attained in the metallurgical operations of English iron and steel works, and papers "on the elimination of sulphur from iron," "the recording pyrometer," "puddling iron," the methods of determining chromium, etc. Each paper is followed by discussion. The second section comprises notes on the progress of the home and foreign iron and steel industries under the following sub-headings: iron ores, refractory materials, fuel, production of pig iron, production of malleable iron, forge and mill machinery, steel, physical properties, chemical properties, chemical analysis, and statistics.

THE LAW AND PRACTICE UNDER THE STATUTES CONCERNING Business Corporations in the State of New York. By Dwight Arven Jones, Editor of the New York Business Corporation Laws since 1884. New York: Baker, Voorhis & Co. 1893. [Sheep. 8vo. 351 p.]

THE value of this work to the business community is sufficiently indicated in the title. The author endeavors, not only to present the existing statute law of the State relating to business corporations, but also to show the connection between this law and the statutes that have preceded it, thus correcting the impression that the State has fallen into a vacillating policy with respect to corporations. The book includes the text of the business corporations law, the stock corporation law, the joint-stock association laws, the taxation laws, and many other important statutes. Thirty-eight forms are also given.

TABLES FOR THE COMPUTATION OF RAILWAY AND OTHER Earthwork. Computed by C. L. Crandall, C. E., Associate Professor of Civil Engineering, Cornell University. Second edition. New York: John Wiley & Sons. [Cloth. 8vo. 42 p. $1.50.]

THE object of these tables is to present a convenient aid in the computation of railway earthwork. The volume is first found by the approximate method of averaging end areas, to which can be added, if desired, a correction due to the strict prismoidal formula, or a correction due to a modification of it for irregular ground. To this edition has been added a proof of the prismoidal formula and a comparison with others in use, a formula for correction for curvature, and rules for cross sectioning.

THE INTERNATIONAL COLUMBIAN NAVAL RENDEZVOUS and Review of 1893 and Naval Maneuvers of 1892. Washington: Government Printing Office. [Paper. 8vo. 238 p.]

THIS is the twelfth annual publication of the General Information Series of the Office of Naval Intelligence. It meets the demand for an authentic and connected narrative of the rendezvous and review at Hampton Roads and New York. There are also notes on naval administration and personnel, ships and torpedo boats, ordnance, and small arms, indicating the progress of the different countries. A list of standard books on professional subjects is added.

ADDRESSES DELIVERED BEFORE THE WORLD'S RAILway Commerce Congress held in Chicago, Ill., June 19-23, 1893, under the Auspices of the World's Columbian Auxiliary of the Columbian Exposition. Chicago: The Railway Age. [Cloth. 8vo. 265 p.]

THE addresses collected in this volume constitute a remarkable body of fact and argument on the subject of transportation. It is not too much to say that they will be found of lasting value and interest. The addresses are grouped under four general heads: railway law and legislation, railway management and operation, railway employés, and railway history and development. There are thirty-two addresses in the volume, and no question of importance has been neglected by the speakers.

OUTLINES OF PRACTICAL HYGIENE ADAPTED TO AMERIcan Conditions. By C. Gilman Currier, M. D. New York: C. B. Treat. [Cloth. 8vo. 454 p. $2.75.]

THE preparation of this book, we are told in the preface, was undertaken at the instance of busy practitioners and students, who emphasized the need of a compendious work upon practical hygiene, embodying the most modern truths and adapted especially to our conditions. Two-thirds of the contents of the volume do not come within the scope of this department; but our readers are interested in that part which deals with water and water-supplies, sewers and the disposal of fluid waste, house drainage and plumbing, and the disposal of garbage and other solid refuse. A judicial attitude is maintained throughout, and no positive opinions are advanced except where there is a consensus of leading thinkers in favor of them.

NEW BOOKS OF THE MONTH.

Astor, W. Waldorf.=The Case for Gold. New York: G. Routledge & Sons. [8vo, 69 p., paper, 25 cts.]

Kemp, Ja. F.=The Ore Deposits of the United States. New York: The Scientific Publishing Co. [8vo, 317 p., cloth, $4.]

Knight, G. H.=Patent Office Manual, Including the Law and Practice of Cases Holding a Revisory Relation Thereto. Boston: Little, Brown & Co. [8vo, 655 p., sheep, $5.]

Lowell, Josephine Shaw.=Industrial Arbitration and Conciliation: Some Chapters from the Industrial History of the Past Thirty Years. New York: G. P. Putnam's Sons. [cloth, 12mo, 120 p., 75 cts.]

Meyer, Franz Sales.=Handbook of Ornament. A grammar of art, industrial and architectural designing in all its branches, for practical as well as theoretical use. New York: Hessling & Spielmeyer. [8vo, 580 p., il., cloth, $3.60.]

Oberholtzer, Ellis P.=Home Rule for Our American Cities. Philadelphia: American Academy of Political and Social Sciences. [Paper, 12mo, 165 p.]

Orndorff, W. R.=A Laboratory Manual. Containing directions for a course in organic chemistry systematically arranged to accompany Remsen "Organic chemistry." Boston: D. C. Heath & Co. [12mo, 40 cts.]

Osborne, G. P.=Principles of Economics. The satisfaction of human wants in so far as their satisfaction depends on material resources. Cincinnati: Robert Clarke & Co. [8vo, 450 p., cloth, $2.]

Pitcher, Ja.=Outlines of Surveying and Navigation. For public schools and private study; to which is appended Washington's farewell address; with 100 questions by J. P. Syracuse. New York: C. W. Bardeen. [Cloth, 37 p., 16mo, 50 cts.]

Ralph, Julian.=Our Great West. A study of the present conditions and future possibilities of the new commonwealths and capitals of the United States. New York: Harper Brothers. [Cloth, 8vo, 486 p., $2.50.]

Tuckley, H.=Masses and Classes. A study of industrial conditions in England. Cincinnati, O.: Cranston & Curtis. [12mo, 179 p., cloth, 90 cts.]

United States, Department of the Interior.= U. S. Geological Survey. Eleventh annual report, 1889–90. by J. W. Powell. Washington: Government Printing Office. [Cloth, $3.]

Wheeler, Candace, Editor.=Household Art. Being a collection of essays on decorative and applied art, the development of homes, etc. New York: Harper. [16mo, 300 p., cloth, $1.]

Wright, Carroll D.=The Relation of Economic Conditions to the Causes of Crime. Philadelphia: American Academy of Political and Social Sciences. [8vo, 116 p., paper, 25 cts.]

NEW TRADE CATALOGUES.

Any of these catalogues free on application to the manufacturers.

The Pratt & Whitney Company, Hartford, Conn.=Descriptive and Illustrated Catalogue. 390 p. [Representing classes of tools and machines produced by the company. Bolt-cutting machines, bolt-pointing machines, boring-mill, drills, lathes, cutters, gages, dies, etc.]

The American Road Machine Company, Kennett Square, Pa.=Good Roads and How to Make them. 48 p. [Consisting of some practical information on methods of constructing, maintaining, and repairing of dirt and stone roads.]

The Campbell Printing Press and Manufacturing Company, New York.=The "Economic." 8 pages. [The latest and most improved two-revolution press; a continuous register rack.]

The Watson Perfect Combustion Heater Company, Toronto, Canada.=The Watson Perfect Combustion Heater. 8 p. [For heating by hot water circulation, steam, and hot air. Chemical and mechanical explanations of the process and apparatus.]

Baldwin Locomotive Works, Philadelphia, Pa. =Locomotives exhibited at the World's Columbian Exposition. 78 p. [Express passenger locomotive, compound express passenger, compound freight, heavy freight, tank switching, etc. The locomotives comprising this exhibit were for the most part built in the regular course of business.]

Thomas Carlin's Sons.=Machinery in Stock. 20 p. [Portable hoisting machines, portable and stationary engines, vertical boilers, steam pumps, heaters, etc.]

The Edward P. Allis Company, Milwaukee, Wis.=Duty Tests of Triple Expansion Pumping Engines. 60 p. [Description of plant and of the tests; the great economy shown by the engines.]

M. C. Bullock Manufacturing Company, Chicago, Ill.=Willans' Patent Central Valve Engine. 24 p. [Describing the central valve high speed engine; retrospect, objections, direct coupling, search, found, economy, tests, etc.]

Massachusetts Institute of Technology, Boston.=A brief account of its foundation, character, and equipment. [Prepared in connection with the World's Columbian Exposition. Illustrated. 40 p.]

Charles Munson Belting Company, Chicago, Ill.=Pure Oak-Tanned Leather Belting. 91 p. [Practical hints concerning use of leather belts, rule for calculating lengths; tables on transmission of power, telegraphic code, price list, testimonials, etc.]

The National Machinery Company, Tiffin, Ohio.=[Bolt and nut machinery, upsetting, bending, spine, rivet, wire nail, and special machinery; also complete outfits for railroad, bolt, car, and locomotive shops.] 172 p.

J. W. Reno, E. M., New York.=A description of an underground electric system. 20 p. [Objections to the system of the Rapid Transit Commission, and description of the Reno system, consisting of a double-decked tunnel of 23x23 feet cross-section.]

The Bucyrus Steam Shovel and Dredge Company, South Milwaukee, Wis.=Catalogue Part 1.—Steam Shovels. Third edition. 44 p. [No. 0, crane pattern, No. 0, boom pattern, No. 1 crane pattern, No. 1 boom pattern, etc., specifications, land dredge.]

The Bucyrus Steam Shovel and Dredge Company, South Milwaukee, Wis.=Improved Processes of Placer Mining by the "Bucyrus" Patent Amalgamator. Second edition. 22 p. [Descriptive of a plant that can deal with large volumes of low-grade deposits and use a very small quantity of water.]

Keuffel & Esser Company, New York.=How to Select Drawing Instruments. 15 p. [Descriptive of the Paragon instruments, material and finish, and showing their superiority; compasses, drawing or ruling pens, spring bows.]

Objects of Interest to Engineers and Others in and about Philadelphia. Engineers' Club of Philadelphia. 110 p. [A copy of a list prepared by the Club for the use of visiting engineers. Objects especially worthy of notice are indicated by single, double, and triple stars.]

THE

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THE COLUMBIAN EXPOSITION FROM AN EUROPEAN STANDPOINT.

By J. Stephen Jeans.

IT will at once be conceded that the World's Fair at Chicago was by far the most extensive, and in many respects one of the most important events of its kind that has ever taken place in any country. It is a credit to the United States and a glory to the city of Chicago. It appears on the first blush almost a miracle that a community which was represented not more than half a century ago by a few log huts in the wilderness, and which little more than twenty years ago was devastated by one of the most destructive conflagrations of which we have any record, should in this year have been able to invite the whole world to assist at an exhibition of arts and industries which, whether regarded as a function or as a spectacle, is incomparably superior to anything that the Old World, with its centuries of civilization and resources, has ever produced.

For such an achievement as this, Europe has nothing to offer but approval, which has been freely bestowed. England has not been behindhand in her admiration of the wonderful virility and enterprise of our "kin beyond sea." But London has been abashed, Paris has been eclipsed, and Vienna has been put completely in the shade, by what Chicago has done. The problem that now appears to be offered for solution is that of *cui bono?* To what end has this enormous expenditure been incurred—this almost superhuman effort put forth, this marshalling of the nations been effected? It is fine as a show no doubt, but what are its other recommendations? What, in particular, is the United States likely to gain by the palaces and towers of Jackson Park and the Midway Plaisance? Is this the beginning of the end, or shall we see still greater exhibitions in the future? Does Chicago now stand at the meeting of the two continents, and, in self-sufficient mood, extend the challenge to the world? Or shall we witness in the future still greater exhibitions, still more costly pageants, still more wonderful triumphs of resource and organization? These are among the questions that are being asked in the older countries of the world to-day.

I visited the World's Fair in June, for the purpose of looking into the exhibits of mining and metallurgy, and drawing up a report on these subjects for the British Iron Trade Association. I was prepared to find the exhibition strong in these departments, having regard to the wonderful progress that the United States has made during the last quarter of a century. Within that time, Europe has been left far behind in nearly all the industries that were formerly more or less special to the European continent, and particularly to England. The strides that have been made in some of the foundation industries over the period named have been truly phenomenal, and have formed, at first a matter of incredulity, then a subject of anxious inquiry, and finally an object of unceasing wonder and admiration to the rest of Europe. Between 1870 and 1890, to take one or two examples, the production of American pig-iron had advanced from less than a third of that of Great Britain to about 20 per cent. more than that of the parent country. In others words, the American development in the interval is represented by 270 per cent., while the British development has not exceeded 31 per cent., and that of Germany has been about 200 per cent. As with pig-iron so with other forms of iron and steel, which it is employed to produce. The American output of Bessemer steel got ahead of that of Great Britain more than ten years ago, and is now almost twice as great as that of the old country. In many different branches of the manufactured-iron trade, in the crucible-steel industry, in the output of iron ores, and in many other subsidiary and collateral directions, the United States has long since gone more or less ahead of every European country. Other minerals and metals have fallen into the same line as iron and steel. The United States is to-day the chief producer of copper, lead, silver, and other important metallic products, which were formerly produced on a larger relative scale in the older countries of Europe, and more especially in England. This striking progress, founded on natural resources of an unrivalled character, has been built up, promoted, and consolidated by a high order of intelligence and capacity in manufacturing industry, which has again challenged the admiration of Europe, and has compelled that imitation which is so sincere a form of flattery. American engineers now lead the world as mining experts, as is almost inevitable from the wider range of their observation and experience, and the much greater variety of conditions that they have to meet. American metallurgists have long ago compelled their congeners in England to own that they were not only original, resourceful, and enterprising, but that their methods were often superior, and their results so marvelous that they have not unfrequently been received with incredulity. In short, American mining and metallurgy now leads the world, alike in extent of production and in the technical skill and capacity at their command. Under these circumstances, I was naturally prepared to find that Chicago would bring to the front the most convincing and complete evidence of what has been achieved by the United States in both directions.

My disappointment may be imagined when I found that most of the principal American firms were not represented at the exhibition at all. Even the Illinois Steel Company, the greatest corporation of its kind in the world, although located at the very doors of the exhibition, was conspicuous by its absence. The Carnegie Company, which is another organization of which Americans have just cause to be proud, which is a monument to the organizing powers of my friend Mr. Carnegie, and which, as constituted to-day, has no counterpart in the old world, was also *non est* at Chicago. And so with many of the other leading manufacturing firms, whether individuals or corporations. When I was in Pittsburgh in 1890, I visited a small local exhibition there which was, probably, on the whole, more representative of American mining and metallurgy, apart from the precious metals, than the World's Fair of 1893, and I believe that if Pittsburgh were to put forth its full strength it could any day make a much better show than that made in this section by the United States as a whole at Chicago. In short, American metallurgy, except in one or two particular cases, can hardly be said to have been represented at Chicago at all. What one might reasonably have expected to find there was not there—such as models of special furnaces and plant, diagrams illustrative of the results obtained in working different processes, collective exhibits of the principal iron and steel manufacturing districts, shown in the form of trophies or otherwise, and similar evidence of that progress which has so visibly compelled European ideas and methods to take a subordinate place, and led Lytton, in his "Coming Race," to declare that he preferred to talk lightly and indulgently of the ancient and decaying institutions of Europe, in order that he might expatiate on the achievements of that wonderful country on the other side of the Atlantic, in which Europe grievously seeks her model and tremblingly foresees her doom.

But while the exhibition was disappointing from a metallurgical point of view, taking a purely quantitative aspect, it was a focus of most of the great mechanical advances of the period that has elapsed since the Centennial at Philadelphia. In the intervening seventeen years the mining industry has grown from a bantling to a giant, the electrical industry has virtually been created, the metallurgical industry has been revolutionized as regards its *situs*, its methods, and its economic conditions, the business of transportation has undergone a marvelous development in reference alike to its dimensions and its cost, mechanical invention has cheapened methods and processes of production all along the line, the United States has taken the first rank in reference to the *technique* of engineering science, and now exports competent engineers as a regular article of commerce, while the country as a whole has witnessed a progress that is without precedent or parallel.

The Chicago exhibition may be approached from its technical as from its commercial side, but it is practically impossible, within the limits of a magazine article, to consider it from both. Or it may be regarded from the point of view of European countries, as exporters to the United States, or from the point of view of the United States, as a country that is aiming at securing a larger share of the business of the rest of the world.

The technical aspects of the World's Fair have already been dealt with at considerable length in publications devoted to the special arts and industries that were represented in the principal sections of the exhibition. Notwithstanding certain important omissions and shortcomings, it is not too much to say that a finer collection of exhibits representative of the applied sciences has never probably been got together. The buildings devoted to the mechanic arts, to mining, to transportation, to electricity, and to manufacture, were a compendium of the world's progress in each branch of those far-reaching subjects. As might have been expected from the country which produced Franklin, Wheatstone, Morse, and Edison, the show of electrical appliances and systems, although limited to comparatively few firms, was remarkably comprehensive, and covered practically every recent advance in electrical science, so that the rest of the world had only to go and see in order to be satisfied, like the Queen of Sheba when she viewed the treasures of Solomon, that the half had not been told. The hall of mechanic arts was alike preëminent in motive power and machinery, and the numerous special papers by experts on both subjects have exhibited in great detail the strides that have been made in these directions since the Centennial of 1876, and the fertility of resource that is so specially characteristic of American engineers and mechanicians. Nothing more wonderful or more complete could well be imagined than the contents of the transportation building, and, as was to be expected of a country that has a railway system equal to that of the whole of Europe and the finest system of internal waterways in existence, the United States has no difficulty in giving points to the rest of the world in reference to both land and water communication. No such opportunity has ever before been afforded to railway engineers and managers of studying on the spot, and under the most favorable conditions, the special circumstances of that greatest of the world's great industries. Nor is it too much to say that there was not a little to learn. European railway engineers have more or less got into a stereotyped rut. They have come to regard their own methods and arrangements as sufficient for all practical requirements, and do not, as a rule, greatly concern themselves about what is going on in other countries. This is more especially true of Great Britain, which, in this, as in most other things of a kindred character, has got insular habits, rooted prejudices, or conservative instincts, standing in the way of progressive movement. I cannot do better than quote, as a case in point, the reply that the late Sir George Findlay, the able and genial general manager of the London and Northwestern railway—the most important line in Europe, as regards capital, cost, and traffic—made to a question that I put to him, in cross-examination, when he was a witness on behalf of that company before the special tribunal appointed by the Board of Trade some years ago to inquire into the subject of rates and charges on British railways.

"Do you know," I asked, "much about the transportation charges and conditions of working on American railways?"

"I cannot say that I do," was the reply. "I have not made them a subject of study."

This answer, which is on record in the printed minutes of the proceedings at the inquiry, will be regarded with surprise, if not with amazement, by leading railway authorities in the United States; but it represents what is probably a typical condition of thought and knowledge in Great Britain. The truth is that English engineers study American railway problems much as a naturalist might study the phenomenon of the fly in amber—not with any idea of applying American experience to their own circumstances, but as a curiosity, if not as a monstrosity, in its own special way. I am not now arguing, nor concerned to argue, whether this habit of thought is natural or proper, nor do I wish to claim that American practice could be effectually transplanted on English soil. I only state the fact as a fact, and I must leave it to another occasion to enter into the question of how far it is justified by the differences of condition and circumstance as between the two countries. Nevertheless, the Americans have compelled English and Continental railways to copy their methods and devices up to a certain point—as, for example, in the Westinghouse brake, the Pullman car, the mechanical coupler, the bogey truck, and other essentially American ideas and appliances. The transportation exhibits at the World's Fair may be expected to suggest and ultimately to bring about other departures from established European practice, on distinctively American lines, but if it should not happen thus, it certainly will not be from any lack of new ideas in railway plant and working, on the part of American roads.

Finally, I cannot fail to make mention of the vast structure devoted to manufactures—the largest building of its kind, and probably of any kind, that has been erected in the world's history, and one which, if it had stood alone, would have made the Chicago exhibition a memorable event. I am not about to enter into elaborate statistics, as some of the guide-books and newspapers have done, with a view to magnify the superlative dimensions of this structure, nor do I propose to even glance at its strikingly varied, handsome, and suggestive contents. With regard to the former I would only say, as indicating the gigantic character of the enterprise, and the comparatively greater ease with which such matters appear to be managed in America, that this one structure cost almost as much as the Imperial Institute of London, a structure that has been reared by the British empire as a whole, to commemorate the reign of Queen Victoria, under the direct personal guidance of the Prince of Wales, and justly regarded as one of the greatest glories of that reign, considered merely as a piece of architecture. But the Chicago exhibition could boast of many such structures, not of course so large nor so costly, but not less beautiful and not less worthy the attention of mankind as regards their architecture, their arrangement, and their contents. I would not, again, venture to either describe or criticise the contents of the Manufactures building, beyond the remark that amid much that is beautiful, interesting, and new, the arts and industries of Japan command the attention of the most casual observer. A glance at the catalogue will show that the Japanese had a numerically larger exhibit in the Manufactures building than any other nation, not excepting even the United States, and this is a circumstance that must be pregnant with meaning and fraught with issues of importance, as regards the future, and one which for that reason European nations cannot afford to disregard. Japan is one of the most enterprising and progressive of Asiatic countries, and one, moreover, that the United States, both by geographical position and adventitious circumstances, has come to regard as a natural market. The trade between the two countries has enormously increased during late years. Since 1878, the imports of Japanese goods into the United States have more than trebled in value, while the exports from the United States to Japan have increased by about 50 per cent. The complete capture of the Japanese market by American manufactures may be finally accomplished under a modified tariff and a rigid adherence to the principle of give and take, and the present display at Chicago is likely to effect a good deal in this direction. So also, in a more or less modified degree, with the markets of South and Central America. Of late years the United States has made greater inroads upon these markets than any other country. Since 1878, the American exports to Mexico, Brazil, and Chili have fully doubled in amount, while those to the States of Central America have more than doubled, and the extent of the trade in both directions is increasing every day. This is not by any means a spasmodic or accidental movement, but one which is steadily growing in strength and volume, and is likely to make still greater headway when the Nicaraguan canal has been completed.

Another feature of the Chicago exhibition that marked it as a thing *sui generis*, and imparted to it a distinctly American character, was the immensity of its component parts as well as of its *tout ensemble*. This feature was apparent throughout the whole exhibition, from the largest building on the ground to almost the smallest essential detail. The motive power was a striking case in point. At the Centennial exhibition the great Corliss engine, which developed about 1400 horse power, and was regarded as the greatest mechanical wonder of its day, furnished practically the whole of the motive power required for Machinery Hall. But at the Chicago exhibition not less than 24,000 horse power were employed, of which nearly one-third was used for driving exhibits of machinery. The increase of power was not more remarkable than the increase in quality. Superfluous bulk had been got rid of, and the Columbian Exposition of 1893 was, as a rule, a much more perfect machine, alike as regards power, cost, mechanism, and economy than its predecessor of 1876. Then, again, we had at the Columbian the largest guns, the largest armor-plate, the largest hammer, the largest dynamo, the largest search-light, the largest landing-stage, the largest lake or river steamer, the largest locomotive, and not a few other things besides. This characteristic of the exhibition is likely to make a new point of departure in the history of each and all of these objects, while it will not be forgotten that the World's Fair has synchronized with the construction of the largest Atlantic liners in the old world, and the commencement of the largest Atlantic liners heretofore attempted in the new. More power and size, but especially more power in relation to size, appears to be the demand on both continents, and that demand the people of the United States have so far, and especially in their display at Chicago, shown themselves fully competent to meet. All this opens up a wide and long vista of possibilities, which the discerning and judicious will not fail to take account of. The Pharaohs who built the pyramids and the imperial Romans whose works are still a source of lasting wonder, are already left behind. What surprises and achievements has the future yet in store?

From an European point of view, it need hardly be said that one of the principal, if not absolutely the chief, considerations that have been present to the minds of intending or possible exhibitors has been this,—how far it would be possible to bring about an increase of business by being represented at Chicago. The day has almost gone past when important business firms have cared to make a great display at any exhibition for the sake of mere honor and glory. The utilitarian is now the principal standpoint assumed by manufacturers and merchants, and especially so in times like these, when profits have to be cut very fine, and when the margin available to "play with" is so very small. British manufacturers, it must be confessed, have not seen their way to a due return by showing at Chicago, taken as a body, and hence the majority of the largest firms have not been represented at all, notwithstanding the efforts made by my friend Mr. James Dredge, in papers read before the Society of Arts and elsewhere, and by my friend, Mr. H. S. Caine, M. P., in a paper submitted to the British Iron Trade Association, to induce an adequate muster. Stony indifference, or keen resentment of hostile tariff legislation, has kept British manufacturers aloof.

There is no gainsaying the fact that the McKinley Tariff act struck a great blow at the commercial relations of the United States and Great Britain. Its avowed object was to secure American markets for American manufacturers, and as a consequence to dispossess British manufacturers who were already in possession. That object has only partly been attained. The damage which the act has inflicted on British trade interests is not nearly so great as was at one time anticipated. Even the tin-plate industry of South Wales continues to survive, and even to flourish. But the intent and tendency of American tariff legislation were none the less apparent, and both being unfriendly to British interests, the typical Britisher made up his mind to leave Brother Jonathan and his exhibition severely alone. It does not appear as if the exhibition had suffered greatly in consequence, and if any suffering should follow this probably most natural action, it may easily fall on the British industrial himself. At any rate the imports of European produce into American markets are still large and increasing, as the following figures show:

IMPORTS INTO THE UNITED STATES FROM EUROPE.

	1878.	1892.
Austria-Hungary	$ 272,000	$ 7,718,000
Belgium	3,982,000	10,273,000
France	43,378,000	68,554,000
Germany	34,790,000	82,907,000
Italy	6,711,000	22,161,000
Netherlands	2,774,000	10,886,000
Portugal	429,000	1,966,000
Russia (in Europe)	600,000	4,926,000
Spain	3,265,000	5,207,000
Sweden and Norway	137,000	3,754,000
United Kingdom	107,290,000	156,300,000
Totals	$203,648,000	$374,652,000

Here we find that there was a proportionately smaller advance in the imports of British produce into American markets, as between these two years, than in that of any other European country, and that while the mother country furnished over 50 per cent. of the total American imports from European countries in 1878, she only contributed about 43 per cent. in 1892. In the interval, the progress made by Germany, France, Belgium, and Italy has been very striking indeed, and proves conclusively that in those countries England has watchful and determined competitors. The success of that competition will probably be even more marked in the future than it has been in the past, all the more so if England allows her rivals to so far excel her in the impression made on possible buyers of her wares as she has done at Chicago, where Germany has gone far ahead of her in iron, steel, chemicals, and ordnance ; where France takes an unquestionable lead in *articles de luxe ;* and where the manufacturers of Belgium have made good their claim to be regarded as serious competitors.

Until now, the United States has done comparatively little in the way of exporting manufactures, but the last few years have witnessed an expansion of the means of production in most branches of industry that is far ahead of the home demands, and have compelled manufacturers to seek for markets abroad. Dear labor and other well-known causes have hitherto hindered progress in this direction, but the progress has, nevertheless, been real, if not rapid, and American locomotives, cars, machines, and tools, may now be found in most civilized countries. The advance in the export trade made since 1878 is thus shown:

EXPORTS FROM THE UNITED STATES TO EUROPE.

	1878.	1892.
Austria-Hungary	$ 2,831,000	$ 1,527,000
Belgium	23,537,000	48,785,000
France	55,319,000	99,126,000
Germany	54,809,000	105,521,000
Italy	8,741,000	14,317,000
Netherlands	13,300,000	43,917,000
Portugal	4,011,000	4,091,000
Russia (in Europe)	11,002,000	6,698,000
Spain	8,205,000	11,528,000
Sweden and Norway	2,807,000	6,579,000
United Kingdom	387,430,000	499,315,000
Totals	$571,992,000	$831,404,000

Whatever purpose the European exhibitors at Chicago might have in view, there can hardly be a doubt that the American exhibitors were there for business. "*Le véritable genie de notre époque*," said M. Thiers on a memorable occasion, "*consiste dans le simple bon sens*." This remark is especially true of the practical and hard-headed American people, who do not allow much sentiment or shadow-hunting to stand in the way of their realization of practical ends. Whatever, therefore, may be the issue of the Columbian Exposition, from an European point of view, there cannot be a doubt that it has afforded to American manufacturers a grand opportunity for extending their trade relations with the rest of mankind, and one which is likely to bear more or less fruit in the time to come, according as the economic circumstances of the country are adapted to cheap or to dear production. If I might be permitted for one instant to tread on polemical ground, I would add that in my own opinion American manufacturers have everything to hope from the repeal of the tariff, and, in their present advanced circumstances, very little, if anything, to gain by its continuance.

CAUSES OF FAILURE IN "BOOM" TOWNS.

By H. S. Fleming.

BETWEEN 1884 and 1889, in the United States, a vast amount of experience was gained by those who sought to acquire sudden fortunes through speculations in "boom" towns, and as subsequent years have shown, they have in the majority of cases paid well for their knowledge. Those who were not financially interested in the great number of small towns which sprang into existence throughout the West and South during that period, may find instructive reading in the printed matter issued by some of the companies, but the unfortunate ones who held on and are still "interested" will, in view of the present situation, find in such studies a lesson on the value of facts and common sense as they relate to business ventures in general, and to "boom" towns in particular.

What we know as "booms" are no new thing. No less a personage than General Jackson was, in the early part of this century, a leading figure in "booming" the little town of Florence, Alabama, and, if accounts of that time can be relied upon, this frontier post, surrounded by a wilderness, with no neighbors but Indians and with no means of transportation other than the long trip down the Tennessee river to the Ohio, was so aroused that the price of lots was higher than it has ever been since. Early in the "thirties," according to Judge Cooley's history of Michigan, a "boom" of magnificent proportions spread throughout the timber region of that State, inflating values to preposterous figures, and finally collapsing. In the latter part of the same decade the construction of the James river and Kanawha canal, in Virginia, gave rise to a similar "boom." Along the line of the canal land values rose to impossible figures, and it was freely predicted that Lynchburg would within a short time outgrow New York in both population and commerce. During nearly every decade there have been "booms" in different parts of the United States, more or less local in nature. There have been the gold fever, the petroleum excitement, and the natural-gas craze, but about 1884 a general "boom" seemed to take place throughout the country, its effects showing more clearly in the less developed States of the South and the Northwest.

In each section the "boom" has had some distinctive features which, successfully carried out in one town, were immediately adopted in others. Throughout the East, suburban development assumed the general features of a "boom," though of course the East was too dignified to allow such a term to be applied to it. In the region around Kansas City, in the West, railroad developments and agricultural possibilities were the main features; at Wichita, Kansas, which experienced the greatest and most disastrous of all modern "boom" failures, railroads and the ultimate opening of the rich agricultural lands of Indian Territory; in the Northwest, railroads and wheat farms; in Washington and Oregon, timber resources and natural harbors; in California and some other States, fruit-growing and irrigation, the latter especially taking a strong hold in the West; finally, in the South, mineral resources were the basis, with the exception of a short though none the less active flurry over Florida orange-lands.

Referring more particularly to the "boom" in the South, with which section the writer is most familiar, it is noticeable that apart from the excitement in Florida orange property, which was purely local in character, there was no inflation of any kind in the agricultural regions or in the larger and well-established cities. On the contrary, there was a natural growth which, it is only fair to say, has been even greater since the collapse of the "boom" than during its most exciting days. Another matter which should be stated in justice to the South is that the vast majority of "boom" towns which were started were from their inception to the end the schemes of speculators from the North and, in the majority of cases, from New England, while the steady and permanent growth both during that time and since has been the work of Southern people or those who have cast their fortunes with the South.

In the mineral region the "boom," when once started, gathered headway with almost incredible rapidity,—new towns, furnaces, factories, and mines being started everywhere, while prices advanced at a rate which cannot be appreciated by any but those who were on the ground. Beyond question the town of Birmingham, Alabama, inaugurated the "boom" in the South. In 1870 some gentlemen connected with a railway then being built from Montgomery to Decatur, crossing the line of the Alabama and Chattanooga railroad in Jones Valley, near the town of Elyton, knowing of the extensive deposits of iron ore and coal in that vicinity, purchased some 4000 acres of land at $25 per acre, paying three-fourths in cash and the balance in stock of a company to be formed. The Elyton Land Company was then incorporated, with $200,000 capital, in shares of $100, one-half being paid in, and the lands already purchased transferred to it. Work was commenced in laying off streets and a few buildings were erected. In June, 1871, the first sale of lots was held and one of these, which was sold for $100, is still retained by the original purchaser and is valued in the neighborhood of $50,000. Up to 1879 the affairs of the company prospered but poorly. Its stock had been as low as $15 per share and debts of about $150,000 had accumulated against it, but during the latter year the erection of the Alice furnace was commenced and a few months later the works of the Birmingham Rolling Mill Company were under construction. From then until 1883 there was a rapid gain, the company's debts being cancelled, many improvements made on its property, and a dividend of 100 per cent. paid on its stock. From this time forward the success of the company reads more like a tale from "The Arabian Nights" than nineteenth-century business. During 1886 dividends amounting to 340 per cent. were paid, and in 1887 alone the dividends for that one year were over 20 hundred per cent. From 1883 to 1887 the total dividends paid amounted to nearly 30 hundred per cent. on the capital stock or about 60 hundred per cent. on the original investment, and besides these dividends the company had spent more than $1,000,000 in buying more real estate, erecting manufacturing plants and otherwise improving its property, and to-day has properties and franchises valued at several million dollars.

Naturally, with such an example before them, town "boomers" found a fertile field in which to work and put forth their efforts to duplicate the success of Birmingham. The strength of this town lay first in its mineral resources and secondly in its railroad facilities; consequently each new town that was started based its claim for future prosperity on the possession of these two features, usually claiming them to a preëminent degree, and for itself the feature of being the center of the universe and a spot where the cheapest iron on earth could be made. The *sine qua non* of a "boom" town was a blast-furnace, and unless it either had one or was going to without delay it could not expect to compete with towns which were making preparation for dozens of furnaces. Of course other branches of iron-manufacture were to follow, and then any industry that might be secured.

There was a feature about these "boom" towns which must be referred to with both shame and regret on the part of the engineering profession. In order to start a town the promoters had need for reports on the coal, iron-ore, and other resources of their property. In some cases the so-called "practical" man was employed for this work and usually lied in proportion to the amount he was paid. In most instances, however, engineers who were professedly honorable men made the examinations and, in the vast majority of cases, either deliberately misrepresented the facts, or were criminally misquoted in the published reports. Cases are known where, upon an honest statement of facts being submitted, the report was suppressed and other men employed who would not hesitate at dishonesty. That such a thing should have been permitted without any action on the part of the engineering societies has tended beyond doubt to lower the standard of the profession before all who have had any connection with these enterprises.

The usual method of starting a "boom" town was for the promoters to select the place to be operated upon and quietly secure options on as much land within it as possible, and large tracts around it. The interest and coöperation of capitalists was then secured and a company organized, stock being sold, and if necessary bonds issued, to provide money with which to take up these options and carry on the necessary improvements. This done, efforts were made to induce the owners of manufacturing plants to move them there, enterprises were organized by the stockholders and promoters, and attractive reading matter prepared to advertise the town and its resources, and what was to be done to insure its growth. So soon as things were in readiness a "first sale" of lots was advertised far and near, all kinds of inducements being offered to secure a large attendance. Excursions were organized to start from various cities, running through trains of sleeping-cars to the town, usually at reduced fares, and sometimes free. Such announcements naturally drew many people who hoped, from reports received from their friends or through the papers, to be able to buy a lot, part cash and the balance in a number of years, and sell at a profit before the first payment became due. Some few purchased with the intention of making the new town their home, but these were in the minority. As an instance, during the "boom" at Cardiff, Tenn., five train-loads of Pullman cars left Boston, reaching Cardiff in time for the sale, and in three days over $1,000,000 of property was sold. The town does not contain twenty people to-day.

As a rule these "first sales" were gambling ventures, pure and simple. The lots had practically no intrinsic value, while their prospective value depended entirely upon the realization of promises made by the company. The transactions which took place at the beginning of the sale, usually in charge of an experienced auctioneer, were made to persons interested in the company for the purpose of establishing valuations in different parts of the embryo town. When the general public commenced to bid, if the prices showed any signs of declining, the promoters or their agents again came to the rescue. Tricks and subterfuges of all kinds were resorted to and promises of almost anything might be had of the promoters. In the excitement, manufacturing and other enterprises were "projected" at a moment's notice, and companies with millions of "capital stock" organized by a word. Business men who might be unduly conservative at home were completely carried away and would enter into the most improbable schemes in all seriousness of purpose, fully expecting to realize within a few days' time.

An interesting example of the "boom" town is Fort Payne (near Birmingham), Alabama, which was quite prominent at one time. This town is situated in a valley whose once fertile soil has become impoverished by the continual growth of one crop. On either side are hills and mountains, the mountain on the east containing at its top two thin seams of a poor quality of coal, while on the west side, in a range of low hills, is an equally thin seam of fossiliferous iron ore which, as it dips under the protecting cover of the country rock, becomes so impregnated with lime and low in iron that it is commercially valueless. A few small deposits of brown hematite are also found in these hills, but not in sufficient quantity or of a quality to be useful. Limestone is abundant near the town. Back on the mountain to the west, from ten to twenty miles distant, there is a fair supply of timber. The Alabama Great Southern railroad passes through the place, giving access to the south through Birmingham and to the north by way of Chattanooga. Certainly these resources do not appear to have been enough to warrant any great industrial establishments; yet promoters took hold of it, organized a company, and advertised it in glowing terms. According to the prospectus the officers of the company were all New England men of high standing. The company owned 32,000 acres of land, abounding in inexhaustible quantities of iron-ore, coal, kaolin, fire-clay, limestone, timber, and water. Three thousand acres of land adjoining the town were set aside as town-site lands. In the words of the prospectus of the Fort Payne Coal and Iron Company:

The company has laid the foundations broad and surrounded the enterprise with men whose financial skill and judgment are a guarantee that the inexhaustible resources of this fine property will be carefully and fully developed, and, as a natural result of such development, a city will rise in its midst. The lands of the company contain in illimitable quantities the two great staples, iron and coal, supplemented by vast forests of hardwood timber, combining in one plant and in juxtaposition all the elements of a manufacturing city.

Referring to the minerals the prospectus says:

First in importance among the mineral deposits of the lands owned by the company comes that of iron. The distinct veins of fossiliferous red hematite ore have been developed for a distance of twelve miles on the property; it is known to underlie some 23,000 acres of these lands. From numerous analyses and tests made this ore is found to run high in metallic iron, ranging from 35 to 60 per cent. in iron. By reference to the reports of experts in another part of this prospectus it will be seen that the ore is, to a large extent, self-fluxing,—a very desirable feature, requiring less limestone in the furnace and largely increasing the percentage of iron from the basis of cost. It is estimated that the two above-mentioned veins contain 200,000,000 tons of iron on this property alone.

But no mention is made of the report of a prominent engineer from New York city, who, after examining the entire property, condemned it as valueless for the purpose intended. A company was organized which erected a blast-furnace, operating it during the "boom" at an enormous loss, the iron produced costing in the neighborhood of $20 per ton. Another furnace was started but never completed. A railroad ten miles long was constructed to the top of the mountain to develop the coal-mine. One hundred coke-ovens were erected. A big steel-plant was partially completed. A large factory was built for hardware specialties, an extensive fire-brick and terra-cotta works was erected, and foundries, machine-shops, a basket factory, asphalt-block works, and other small industries started. Waterworks and electric-light plants were built, besides many cottages, stores, office buildings, banks, hotels, and schools. Half a mile from the center of the town lots sold for $10 a front foot, and in the business part sales were made for $250 or more. They are now worth practically nothing. The resources were myths. Those who invested took the shadow for the substance and have suffered from their lack of judgment.

While this is only one of many such towns, it must not be supposed that all of the places "boomed" had such slender foundations upon which to stand. In one sense the exact reverse is the case. Not that the actual resources were so great as each claimed, but there were few cases in which some real merit did not exist, and, had the promoters been willing to go to work upon a legitimate basis, great good would have resulted where there is now ruin. For instance, Middlesborough, in eastern Kentucky, is in the heart of a fine coal region, and has near it extensive forests of valuable woods. The development of these would have resulted in a town of fair size and undoubted prosperity, but to build there such a city as was anticipated by its misguided stockholders, was an absurdity which no unbiased mind can view with anything but pity. The town in which thousands, even millions, of dollars were spent, is now almost deserted, and would be entirely so were it not for the coal mines and some woodworking establishments. Another such instance may be found in the town of Tallapoosa, Georgia, which was the scene of one of the most extensive and rascally frauds ever perpetrated in the South ; another in Cardiff, Tennessee, which was conceived by people interested in Fort Payne ; still another in Sheffield, Alabama, and its sister town across the river, Florence, once the seat of General Jackson's efforts, boomed this time by Philadelphia people. But the list is too long to be given here.

The reason why these places have failed to succeed according to their expectations will be apparent after a moment's consideration of the conditions necessary for the growth of any town. Basing its prosperity upon its possibilities as a manufacturing center and granting that it possesses all the resources and railroad facilities necessary for such purpose, it must secure the establishment of various manufacturing enterprises. These will need many employés who will buy provisions, household goods, clothing, and the various necessaries of life from stores. In this way the basis for mercantile business is established. To carry on the business banks are necessary for convenience and safety in handling money ; thus the financial end is founded. The employés of the manufactories, mercantile houses, banks, and other branches of business will need houses to live in, and these must be erected upon land which, necessarily, is purchased from the town company.

Assuming that each manufacturing plant is on a sound financial basis, running full time and employing steadily its quota of mechanics, laborers, and clerks, producing goods below the selling price and finding a ready market for its entire output, then money will come to the town through these sales, be distributed through employés to the stores, and sent away through the banks in payment for merchandise purchased. Part of the money goes for rent or in payment for homes, and, as these are built on the land company's property, they consequently secure an income from it, both from homes and business houses. As manufactories increase in number and size, so does the volume of business ; consequently a business man can afford to pay a higher price for land upon which to erect a store. So also the clerk or laborer can pay more for his home, since with money circulating freely their wages are good and the continuance of such wages assured. Thus values increase in proportion to the advance in the volume of trade, in a manner perfectly legitimate and upon the solid foundation of prosperous commercial intercourse with other places.

This is the *theory* of " boom " towns, but it is too nearly elysian to be found in practice. In the first place the enterprises secured were not always adapted to the particular resources of the place. Those which were not had but small chance of succeeding, while both these and those which were so suited, were, almost invariably, started on such an extensive scale and so hampered with enormous capitalization, bonds, mortgages, and debts, that in a financial sense alone their continuance was doubtful. Added to this was the fact that each was in a new territory and had to contend with many troubles, such as securing the necessary amount and proper kind of labor, arranging for a steady supply of raw material, and finding a market for the product. These details cannot be overcome in a day,—it takes years to perfect them. Manufacturing plants moving from Northern cities, as a great number did, located in the new towns more because of the inducements offered than on account of the resources, and few of them could retain the business of their old customers, but had to seek new markets. Another trouble was that, as a rule, all of the money subscribed to or invested in the new plant was expended in salaries, buildings, and machinery, so that when completed and in readiness to operate there was none left with which to purchase material or run the plant, to say nothing about sending out men to introduce the goods. As a natural result, when the construction of various works was completed, there was no further employment for the laboring classes and mechanics, and the distribution of money through them ceased. This immediately affected the merchant, and, through him, the banks. Property became less valuable because stores could not pay high premiums for land while doing a small business, and the mechanic and clerk were either thrown out of work or received smaller pay, and as a result were unable to purchase or rent a home for such a price as before. The land company's property consequently depreciated in value.

There is a logical sequence in the rise and fall of a "boom" town which, while interesting to watch from an entirely disinterested standpoint, has brought disaster to many a would-be speculator who laid down his money, earned and saved in years of hard work, with the hope of being able to make enough in one or two transactions to give him a competence for life. The secret of the failure of "boom" towns lies in the fact that the promoters and investors discounted the future while deliberately closing their eyes to the present. They disregarded the most common rules of business with a persistence and blind obstinacy truly marvelous. Never stopping to reason they plunged into a sea strewn with half-covered reefs of financial ruin and allowed the wind of excitement and enthusiasm to blow them about at will, and when they finally struck a rock and were wrecked, they blamed not themselves, their greed, or their blind impetuosity, but the town, its over-estimated resources, and everything else which failed to meet their hopes, forgetting that the facts were before them all the time.

It is safe to assert that 90 per cent. of the towns "boomed" in the southern States, which are now failures, would now be in a healthy and prosperous condition had they been started and carried on in the manner usual in business enterprises. As it is, the collapse of the "boom," together with the past three years of financial depression, has dealt them a serious blow from which they have been slow to recover. A movement for the better started some time ago, but it has been slow, very quiet, and very earnest. Big factories and works have changed hands, the new owners securing them for a small part of the original cost and starting with a limited force, producing only so much as can readily and profitably be disposed of. This movement is general and is the precursor of a substantial industrial growth which will soon be beyond the reach of "booms" or any other undue inflation of values.

The lesson of the "boom" will never be lost to those who were engaged in it, but no amount of preaching will prevent the repetition elsewhere of this state of affairs. There are still many persons who believe themselves wiser than all the rest of mankind, and when a "boom" starts in some part of the country, as will probably be the case within the next one or two years, there will be found plenty to go into it with money and hopes, to come out only with experience and debts.

THE IRON-ORE REGION OF LAKE SUPERIOR. II.

By Richard A. Parker, C. E.

THE GOGEBIC RANGE.

IN 1883, rumors of the occurrence of soft red hematite near the western boundary of the Upper Peninsula, following the trend of the old Marquette range, were current upon both the Marquette and the Menominee ranges. A few men from the iron mines, with their "outfit" of flour, bacon, kettle and pick, worked their way westward over the trail leading to the Indian reservation near Ashland, Wisconsin. Finding signs of ore, they prospected and were rewarded by the discovery of ore beneath the roots of a tree upon a hill, south of the present site of Bessemer, Michigan. This proved to be the wonderful Colby property, which made such a record for rapid development and yield from the day of its discovery, and which is to-day in position to make an annual output of 300,000 long tons, or over. Shortly after the discovery of this mine, Mr. A. Lanfear Norrie, of New York city, took an "option" for a lease upon lands owned by a large land corporation, and his men found the mine which proved to be one of the largest underground producers of iron-ore this country has known. This property he subsequently leased to the Metropolitan Land and Iron Company, at a slightly advanced royalty over that paid by him to the land company. In the meantime, the Milwaukee, Lake Shore and Western railway, having its terminus in the pine woods, and operating largely as a carrier of pine logs, surveyed a route to the mines and on to Ashland, Wisconsin, a distance of about forty-five miles from the mines, where a lake port and dockage room were available. In 1884 the first shipment was made from the Colby mine of one cargo of 1022 tons of ore. By the end of 1885 there were eight producing and shipping mines, whose total output was 119,860 long tons. In 1886 thirteen more names were added to the list of shippers and the total of 747,589 tons was reached. From that time on the district has maintained a steady growth and held its position, so quickly assumed, of second in importance of amount of ore shipped annually ; but in 1892, with a maximum shipment of 2,973,993 long tons, it stepped to the front rank of Lake Superior iron producing ranges. The largest annual output from any one range was made by the Marquette range in 1890, when it shipped about 20,000 long tons more than the maximum Gogebic range output. Since the opening of the range in 1884 up to the close of 1892 the Gogebic range has sent to market 13,260,206 long tons of ore, all of which was soft hematite.

Much excitement attended the birth of this range, of which advantage was taken by unscrupulous schemers to fleece the unwary. Trenches a few feet deep and wide, run in a body of jasper that contained enough hematite to color the surface water red, were inspected by the tenderfeet, who were easily led to believe the fabulous stories set afloat by the manipulators. Options for a lease were put into stock companies—leases, of course, being the more usual mode of procedure in the stock gambling. Forty thousand shares were usually issued at a par value of $25 each ; and $4, $5, and $6 per share was not an unusual price for one of these jaspery options. Red water, of course to the uninitiated, meant ore, and that meant the doubling of the prices of stock. In several instances the entire issue of 40,000 shares of stock was sold—the proceeds going to the vendors, leaving the company without treasury funds of money or stock with which to carry on mining operations. However, the reaction came in due time, the properties passed into the hands of iron-ore men of experience, and the range has emerged from its infantile diseases, a strong, healthy child of Michigan.

The ore lies in a V-shaped trough which has usually a pitch or slant to the east ; the left leg of the V being usually the quartzite footwall. Sometimes it is a dense, impermeable wall of jasper lying north of the persistent quartzite from 30 to 60 feet; the left leg is a more or less decomposed, intrusive diorite sheet ; while over the ore-body, in a more or less rounded cross-section, is the banded jasper schist of the range, and from which, by leaching, alteration and concentration, the ore has been derived. While there is usually but one footwall, there may be several dykes, one underlying the other, upon which ore is very frequently found. These dykes also tend to split into two or more, each carrying its varying amount of ore. They are quite continuous in the direction of the trend of the range, and have been known to extend for over two miles.

The usual method of removing ore is by the use of heavy sets of timbers two to three feet in diameter, framed to form the skeleton of a cube, usually 7 feet 4 inches from center to center. These square sets or frames reach from one side of the deposit to the other, and from the floor of the level up to the roof or floor of the overlying level. They offer a means whereby the ore can be attacked and removed, at the same time temporarily supporting the roof. At intervals pillars of ore are left to support and keep the roof from caving unexpectedly. These pillars are afterwards removed by cutting into the center of the pillar at right angles to its length, then driving a drift in the direction of its main axis to the hanging wall ; the ore close to this wall is then removed and its place taken by timber. This continues until the wall gives signs of weakening and the timbers show that the great weight of rock is bearing upon them. At times, a post 2½ feet thick is crushed and mashed upon itself, and caps are squeezed into one-third or one-fourth of their original diameter. When this pressure evidences itself, the ore in the pillar and near the rock is lagged up ; that is, poles 4 to 6 inches in diameter are laid closely together to exclude rock or sand, and work at this pillar is temporarily stopped until the hanging wall has crushed the timbers and fallen in. The miners then attack once more the ore in the pillar, and draw back or away from the barren wall of rock until it is again time to vacate. The result of such a system of caving is to wreck the surface ; it follows down as the ore from the several levels is removed, until, as one now stands and views the chasm made by man, it cannot but give him the feeling that it is exceedingly unsafe to be underground, while the fact is, that the mine is in an exceptionally safe working condition, and a very high percentage of the original body of ore is obtained in this way.

The product of this entire range is a soft hematite averaging 62.5 per cent of metallic iron—some of the properties shipping for an entire season ore that will run 1 per cent. above this average. The greater portion of the output is ore that is very low in its phosphorus content, so that it is available for steel making by the Bessemer process. This is true to a remarkable extent, considering the great output of the range. None of the other ranges are fortunate enough to possess the same quantity of this grade of ore, though each has its quota.

The total shipment of ore from the Gogebic range, up to the end of 1892, has been 13,260,206 long tons, or an average of 1,473,356 tons for each year it has had shipping facilities.

THE VERMILION RANGE.

SIMULTANEOUS with the opening of the Gogebic range in Michigan and Wisconsin, the Vermilion range of Minnesota heralded the news of its valuable possession of ore deposits, and made its first shipment of 62,124 tons of ore the same year (1884) that the Gogebic range made its initial shipment.

In 1875, explorations were in progress near Tower, Minnesota, and by trenching across the ore-bearing rocks, the main seam of ore, which ultimately proved to be that now operated by the Minnesota Iron Company, was found by a party exploring under the direction of Mr. Stuntz, of Duluth, Minnesota. Trenches had been cut in numerous places, and one showed a seam of clean hematite thirteen feet wide that was very hard, and, with the tools and black powder then available, almost impossible to test and break. However, a mass of ore weighing nearly 60 tons was broken off and sledged with hammers until the face of clean ore was exposed, which ran 67 per cent. in metallic iron. Five years afterwards, systematic explorations were again resumed by Mr. C. Tower and Mr. Munson of Utica, New York. This year, the explorations were in charge of Professor Chester of Hamilton College, New York, and were confined to what is locally known as the Soudan bluff, but he evidently failed to find satisfactory evidences of ore, for athough supplied with provisions for three months, work was stopped about September 1. The next year work was again resumed, and a large deposit, having a width of 25 feet was developed. Numerous trenches were cut, as sinking on the ore could not be followed long on account of the difficulty of handling the incoming water. Black magnetite had been found on the Tower bluff, in a belt of jasper, but it carried too much sulphur near the surface to warrant its being developed further. Work was then prosecuted east of this belt of jasper and the seam just referred to opened up. This is the property now operated by the Minnesota Company and for which, together with the Chandler, Zenith, and other mines, the one hundred miles of railroad and large docks at Two Harbors were built.

In the southeast corner of section 28, town 63 north, range 12 west, is located the Chandler mine, a soft-ore deposit which has achieved a great reputation on account of the amount of high grade ore produced annually. It is second in output only to the Nomi mine upon the Gogebic range, while its average grade is somewhat better. The advisability of pumping out Shagawa lake, lying north of the

EXPLORING CAMP ON GOGEBIC RANGE IN 1886.

mine, has been discussed, in order to reach the ore believed to lie below it; but, owing to the volume of water to be removed, and the element of uncertainty still remaining as to whether the work of this nature undertaken at Ishpeming, Mich., will prove successful or not, nothing has as yet been done.

The ore deposits stand at a comparatively high angle and are found in rocks entirely similar to those of the Marquette range. A series of lenses of ore has been opened upon two parallel hills, which constitute the ore-deposits of five or six mines. In the intervening ground, diamond drilling has opened several minor lenses.

"TAKING A WEE BIT SMOKE."
[Group of miners, East Norrie mine.]

Since 1884, the shipments from the Minnesota mine steadily increased, jumping to 225,484 long tons in its second year, while, to the close of 1892, it has sent away 3,521,838 tons of ore, being a close second to the wonderful output of the mines of the Metropolitan Land and Iron Company of the Gogebic range.

THE MESABA RANGE.

About the middle of November, 1890, soft hematite was found upon the land now known as the Mountain Iron mine. Ever since 1875 discouraging reports of the district had been given by ex-

THE CITY OF IRONWOOD, MICHIGAN, JUNE, 1886.

EAST NORRIE MINE, GOGEBIC RANGE.
[Shaft No. 1, with Stock Pile.]

plorers and geologists, owing to the fact that all ore found was "lean" or banded with jasper. Others condemned it because the strata which properly might be expected to carry the ore all lay at a very flat angle to the horizon, while the deposits and lenses on the ranges upon the south shore of Lake Superior all stood at a high angle. However, by perseverance the ore was found, and the general conditions which surround its occurrence were quickly understood, and in an incredibly short time, owing to the simplicity and ease of exploration, the range was developed. Commercially there are but two kinds of ore found—the normal soft hematite and a goethite; the latter, a yellow ore resembling ochre but carrying a higher percentage of metallic iron, and, unlike ochre, is frequently found very low in phosphorus.

The ore lies flat, with a dip to south. Very rarely has it a rock covering, glacial drift only hiding it from view. The ore occurs in a jasper-schist, locally known as taconite, from which it appears to have been derived by erosion of the jasper and concentration of the iron-ore upon the underlying greenstone.

The extent of the range is remarkable, as it has been explored from the Mississippi river as far east as the Canadian boundary on the east, a distance of 140 miles or more. Of course the ore is not a continuous deposit for this distance, nor is the depth of ore uniform. Local causes induced the alteration which has given us the ore. The surface covering of sand, boulders or clay varies in depth from a few feet to over 100 feet, the depth of the ore deposits following these figures very closely also. Owing to the southerly dip, the deposits are frequently wedge-shaped, with the thin edge to the north and thickening to the south until the ore reaches the unaltered jasper schist.

Following the discovery of ore at the Mountain Iron mine, came, after a short interval, the opening of the Biwabik, Cincinnati, Hale, and then the group of mines surrounding the town of Virginia. The first-named property is the one that has by its phenomenal size, remarkable grade of ore, ease of access and broad scale of attack, made it famous in the Lake Superior region. Its owners were the first to evidence faith in steam-shovels by their works. Starting in a manner characteristic of the broad gage of he management shown by its operations at the Hamilton-Ludington mines upon the Menominee range, it began stripping in the winter of 1892–93, which it has continued until the present month (August, 1893), when owing to the universal depression in all mercantile

EAST NORRIE MINE, GOGEBIC RANGE.

[Shaft No. 2—Caved surface in the foreground.]

SHAFTS NOS. 3, 4, 5 AND 6, NORRIE MINE.

[Superintendent Day's Residence on the Left. Stock Pile of Ore in the Distance.]

ORE STOCK-PILES, NORRIE AND EAST NORRIE MINES.

[No. 7 Shaft Norrie over the track.]

enterprises, it has temporarily closed down. Not, however, until it had satisfactorily demonstrated that the ore could be handled with ease by steam-shovels. The writer has sat on a bank of stripping watching the shovel, with its two ton dipper, drop down with a rattle of chains and thud to the base of the breast of ore, up which it climbed, tearing out huge pieces of ore which rolled to the bottom, too large to go into the dipper, and on with its load over to the railway cars standing on a side track. These larger pieces were quickly broken by men with sledge hammers while the shovel was busy elsewhere picking up ore and loading the cars. When

NORRIE MINE, GOGEBIC RANGE.

[Big Pump, 800 Feet Underground.]

seen in operation in June last the breast of beautiful blue (Royal blue of the mine) ore was 15 feet or more in height and gaining as progress to the north or into the hill was made. When the necessary tracks are in place, and the thorough-cut completed so that shovels can be operated without delays other than are incident to such a method of loading, there is no question but that 2000 long tons of ore can be loaded by one shovel in a day of ten hours, and when the plans now laid for the stripping of the property are completed, three shovels can be operated that will easily maintain a daily output of 5000 tons, provided railroad facilities can be provided for this enormous output.

There are several mines which are so favorably disposed as to permit this method of exploitation, notably the Mesaba, Mountain, Adams, and Hale, while others will go underground and pursue the caving or other method which the management deem to be to their best interests to follow, to obtain the ore.

Two railroads have entered the field to carry the ore to lake ports—one to carry it to Two Harbors, the other to Duluth, these ports being about 26 miles apart, while at the latter place a new

NORRIE MINE, GOGEBIC RANGE.

[Pumpmen on Ladderway in the Shaft.]

dock has been building this past summer to care for the ore that promises to be the highest and of the greatest capacity of any on the lakes, and consequently in the world. The following are the general dimensions of this dock: Length, 2304 feet; width, 52 feet; height above water, 53 feet; number of pockets, 384; capacity of each pocket, 150 tons, or a total dock capacity of 57,600 tons.

In order to enter the lists of shipping mines in 1892, the Mountain Iron Company sent away, practically as sample lots of Mesaba ores, two cargoes, amounting to 4245 long tons, which proved satisfactory to the furnaces making a test upon the ore. In spite

WINTER AT THE NORRIE—LOOKING WEST FROM NO. 3 SHAFT.

[Ground Caved to the Left.]

of the drawback of the last season's depression, this range is one that will ultimately prove its strength and value, and be of material assistance to the steel makers of this country, as, with a growing demand for steel, there promises to be a shortage in Bessemer ores. This range will undoubtedly be of great service in forestalling apprehension on this score.

From the pages of Census Bulletin No. 113, issued September 24, 1891, some few figures are taken which will partly confirm the statements made and convey to the general reader some idea of

NORRIE MINE, GOGEBIC RANGE.

[Icicles Underground.]

the magnitude of the interests involved. Out of 14,518,041 long tons of ore mined in the United States, this district produced 7,558,176 tons, or something over 50 per cent. Of the estimated total value of the ore produced ($32,766,506) this region is credited with $19,851,191, or over 60 per cent.

In the census year 1889, Michigan headed the list of iron-ore producing States, while Minnesota ranked fifth, and Wisconsin, sixth. Of the capital invested in actual iron-ore mining operations, amounting to $109,766,199, the lake region shows that it has $54,-825,122, or just 50% of that of the entire country. Of the total an-

EAST NORRIE MINE, GOGEBIC RANGE.
[Tram-car Underground.]

nual expenditure in the United States of $24,781,658 the three Lake Superior iron-mining States, Michigan, Minnesota, and Wisconsin, spent $15,168,352, or over 61 per cent.

The railroads have a large amount of money invested in docks, cars, and engines, which are intended solely for the iron-ore traffic. Exclusive of engines, for which no returns are available, the following will be an estimate of the investment by the ore-carrying roads in cars and docks only:

Chicago and Northwestern	$2,290,000
Duluth, South Shore and Atlantic	1,491,000
Duluth and Iron Range	1,231,000
Mil., Lake Shore and Western	813.000
Wisconsin Central	645,000
Duluth, Missabe and Northern (estimated)	600,000
Total	$7,070.000

In addition there is the investment in main lines, sidings, switches, round houses, shops, scales, etc., which would amount to fifty millions of dollars at a low estimate. There are five mining companies owning their own fleet of ore carriers, varying in number from four to seven in a fleet, all of modern construction and costing from $100,000 to $225,000 each, so that in boats of mining companies alone there would be a probable investment of three and one-half million dollars. The receiving docks at lower lake ports represent a large investment solely for the benefit of ore traffic. The ore dock at Fairport, Ohio, has a frontage one mile in length, with room for stocking ore extending back 180 to 350 feet in width. Two docks at Cleveland, Ohio, are half a mile in length, with storage capacity 350 feet in width :—the capacity of the three docks named will reach from 1,000,000 to 1,500,000 long tons each, as ore is stored from 25 to 50 feet in height. With the equipment of hoisting and conveying appliances, some of these docks cost $800,000 ; there are some fifteen receiving docks, located at nine ports, and a low estimate would place their cost at seven million dollars, so that it is readily seen that the Lake Superior iron ore interests easily command an invested capital of at least $125,000,000, and with the advent of the Mesaba range upon the scene of operations they are apt to reach the sum of one hundred and thirty millions within a very few years.

Whether it be a natural law of all ranges or not, it is worthy of note that in every instance, in the iron districts, the deposits first

TURNTABLE IN EAST NORRIE MINE.

[Timbers Showing Weight and Beginning to Crack.]

LOADING ORE AT BIWABIK MINE, MESABA RANGE.

found and developed have proven themselves to be the principal ones of that range upon which they are located. The Jackson and Lake Superior mines on the Marquette range ; the Chapin on the Menominee ; the Colby and Norrie mines on the Gogebic ; the Chandler and Minnesota of Vermilion, and the Mountain Iron and Biwabik of the Mesaba range, all tend to confirm this statement. Again in the far west, the early discoveries of Leadville showed up the mines that have ever since maintained a uniform and steady output. At Aspen, Colorado, the Mollie Gibson ; at Georgetown, the old Colorado Central mine ; at Butte, Montana, the largest mines were practically all found at the same time and few large ones have since been developed.

The mines of the Lake Superior iron district, in spite of depths increasing every year, are in position to maintain the maximum output they achieved in 1892 for a long time to come. The development of new mines has not tended to this result so much as the bettering of mining methods, and the bringing to the miner's assistance of better powered machinery, new devices, tools, and the application of knowledge gained by long years of experience. The opening of the Mesaba range will not materially interfere with the output or development of the older ranges, as the consumption of ore is increasing annually and the uses for steel are widening, so that it will simply furnish the ore needed for the increased demand.

The foregoing very cursory glance at the several ranges producing iron-ore is incomplete and for that reason unsatisfactory ; to fully describe any one of them would take the space devoted to the five, which in a magazine of this nature is out of the question. To the investor they offer wonderful inducements ; the legitimate field of mining is more fully developed in the Lake Superior district than in any other of equal extent. As a rule, the stock gamblers are weeded out very early in the history of the development of a range, leaving the miner to pursue the even tenor of his way : the product is as staple as wheat, and while it now is suffering in common with all other industries, it will revive as soon as there is any sign of life in the horizon ; for the world must have iron and steel.

NOTE.—The photographs from which the illustrations were made of the Norrie mine and underground workings were kindly furnished by Mr. S. S. Curry, President of the Metropolitan Land and Iron Company. Those taken in 1886 were given to the writer by Mr. J. M. Longyear, of Marquette, who there took them. Those of the Buffalo mines (presented last month) were loaned by the engineer of the company, Mr. E. V. Palmer. The others were specially taken for this paper.—R. A. P.

THE HISTORY OF STRIKES IN AMERICA—II.

By Arthur A. Freeman.

ACCORDING to the historians of the labor movement in the United States the beginning of its second epoch is contemporaneous with the breaking out of the rebellion. The eight-hour movement is held to have received its great impetus during the war. "The demand for arms and equipments, and the distribution of money by bounties," says the editor of "The Labor Movement," Mr. McNeil, "soon compelled more rapid production." Strikes for shorter hours and higher wages followed this revival of industrial activity. While the panic of 1857 had weakened the unions and reduced their membership, and while the increased agitation of the slavery question so engrossed attention that the labor issues were temporarily neglected and it was not really until the end of the war that the full force of the labor revival was manifested and developed, yet the record shows that the circle of organization of workers was nearly completed in 1862. At this time many old unions were reorganized, new organizations sprung up everywhere, and national as well as international associations were created by those who realized that the small and isolated trades union had outlived its usefulness to the laborer. It is stated that twenty-six trades had national organizations in 1860, while many had international organizations. The era of the civil war, says Professor Ely in his history of the labor movement, brought into prominence a vast number of labor problems, due to fluctuations of the currency, rapid accumulation of wealth, and the widening of the field for the labor movement consequent on the abolition of slave labor, as well as to the fact that during the war native labor had been replaced in many quarters by foreign labor. It is not surprising that during the closing years of the war and the five succeeding years a large number of new organizations were formed. From this time forward the history of the labor movement in general is virtually contained in the history of the several large organizations. The movement began to assume a political character, and numerously signed petitions were forwarded to Congress and the State legislatures asking for the enactment of eight-hour laws and other special legislation.

The panic of 1873 and the four years of industrial depression that followed it, instead of checking labor agitation and organization, stimulated it. Men would organize themselves into local unions whenever they decided to strike, and at the end of the strike would generally dissolve and reorganize into assemblies of the Knights of Labor.

We proceed now with the chronological history of the strikes and disturbances during the second epoch of the labor movement.

In 1860 there was a strike of shoemakers at Lynn, Mass., for an increase of wages. There was rioting and attempts to prevent express companies from transporting stock and goods. Soon the strike spread to other shoe-manufacturing towns in the State. On a certain day delegations from several towns came to Lynn, and over 5000 men and 1000 women appeared in line with banners and bands of music, making the largest labor demonstration ever known in Massachusetts. But the strike failed, the vacant places having been filled by men from other States. There was another strike in the same year, also unsuccessful. In 1861 there were two minor strikes. In 1862 there occurred many short strikes throughout Pennsylvania for increase of wages, and they were generally successful. Coal-miners in Illinois also struck and succeeded after a nine months' struggle. The companies tried to import Belgians, but many of them were sent back by the strikers at the expense of the Miners' Union. There were two other successful strikes in that year.

In the early part of 1863 strikes prevailed in many industries. Several collisions took place between strikers and the police. Assaults on non-union men were frequent. Apart from these, there is a record of fourteen different strikes. There were seven strikes in 1864; in one case the militia had to be called out. In 1865 there were numerous strikes in Pennsylvania against reductions, generally unsuccessful. Six other strikes occurred. The Bricklayers and Masons' Union was formed in that year. Six strikes occurred in 1866. In 1867 there was a general lockout by iron manufacturers of Pittsburgh in consequence of a demand of some for an increase. The workmen asked for a conference with the manufacturers, which was granted. The lockout ended in the manufacturers paying the price demanded. In that year occurred the strike of the Pittsburgh stove-molders against a 20-per-cent. reduction. New hands were employed, and this led to considerable agitation and police interference. The strike was supported financially by the International Union and donations from outsiders. The molders expended $18,000 in building a new foundry to be run on the coöperative plan, but the enterprise failed, and after nine months the molders were obliged to return to work. The union fell, as strikers had to sever their connection with it as a condition of obtaining employment. There was also a long and bitter fight of the molders in Cincinnati, which resulted in eleven of the strikers starting a coöperative foundry. Several other strikes occurred. In the same year the decision was handed down in the case of the Master Stevedores' Association vs. certain strikers in which the judge for the first time clearly traced distinctions between conspiracy cases theretofore regarded as entirely analogous. The judge held that "it is not unlawful for any number of journeymen or master workmen to agree, on the one part, that they will not work below certain rates, or on the other, that they will not pay above certain prices; but any combination for the purpose of compelling journeymen to conform to any agreement fixing the rate of wages to which they are not parties, by the imposition of penalties, by agreeing to quit the service of any employer who employs journeymen below certain rates, unless the journeymen pay the penalty imposed by the combination, or by threats, intimidations, violence, or other unlawful means," is an indictable conspiracy. In a New Jersey conspiracy case in the same year it was held that it was an indictable conspiracy at common law for several employés to combine and notify their employer that, unless he discharged certain enumerated persons, they would quit his service in a body. The granite cutters were organized in 1867.

During the session of 1868 the Pennsylvania legislature passed the eight-hour law to go into effect July 1. Agitation began in the collieries of the Mahanoy valley for adoption of the law, and a general strike followed. There was a general suspension of work throughout the anthracite coal fields depleting the coal market and making prices high. In September there was a general resumption of work. There were several strikes of spinners and weavers as well as in other trades. The railway conductors' brotherhood was formed in that year. In 1869 several important strikes occurred, notably that of the Schuylkill miners, who desired to fix a minimum price for mining coal. The absence of Schuylkill coal from the market proved a source of profit to the other counties, where work continued without interruption. When, finally, a compromise was agreed upon and work resumed, it became evident that the long contest had ruined the business of Schuylkill county, her former customers having made permanent arrangements elsewhere. The Knights of Labor organization was formed in 1869 by seven men. Sixteen strikes occurred in 1870. In one case Chinese were imported from California to take the place of strikers. In 1871 there were eleven strikes. Spinners, miners, telegraphers, cigarmakers, and other trades figured in the conflicts. Schuylkill county was again the scene of trouble. The operators refused to treat with their employés through the officers of the union, and a dead-lock ensued. The managers of the Philadelphia and Reading railroad undertook to compel a settlement of the dispute by raising their transportation charges to such a figure that no collieries could work unless all were at work under a common agreement. This interference was bitterly resented by both operators and miners and the matter was considered by a committee of the State Senate, which, however, declared itself powerless to apply a remedy. The matter was finally settled by arbitration.

In 1872 a vast body of workmen, perhaps 100,000, mostly of the building trades in New York city, struck for the eight hour system. At the end of three months the strikers succeeded in nearly every instance. In Pennsylvania strikes prevailed in various trades, for the eight-hour system, but they were unsuccessful. There was an interesting strike of the coopers of New York against the sugar refineries using barrels made in other localities. The strikers declared that they did not question the right of the sugar refiners to purchase barrels where and of whom they chose, but that they had an equal right to work for whom they chose, and hence were acting within their right in declining to work for refineries that purchased barrels elsewhere. The reasoning was faultless, and to-day such a contention would doubtless be sustained by any court. There is no record of the result of this interesting controversy.

A notable strike was that of the miners on the line of the Connellsville railroad for an advance of 1 cent per bushel for mining coal. The strike soon spread to mines along the Monongahela and Youghiogheny rivers. The demand was refused by the river operators, but conceded by the railroad men. Over twenty other strikes are recorded for the same year. A few were against wage reductions, but the majority were for a reduction of working hours from ten to eight. Most of the strikes failed.

In 1873 the printers of several Pittsburgh papers struck against a reduction. The Typographical Union took part, but the strike failed, and the union was dissolved. Suits were entered against printers for conspiracy, but were finally withdrawn. In the same year the miners at Arnot, Pa., determined to organize a union, struck in protest against the discharge of eight of the men prominent in the enterprise. A lockout against all union men ensued. An official of the State labor bureau submitted a proposal which the miners accepted and the company rejected. After many months, the opposition to unions was withdrawn, and work everywhere resumed. Several other strikes are recorded, although the year was one of panic and depression. Strikes were also numerous in 1874. Nine thousand miners in Schuylkill county again struck against a proposed reduction, and the miners along the line of railroads leading to Pittsburgh also went out to resist a threatened reduction. Strikers were replaced by Italians, and shots were exchanged between the old and new workmen. In Scranton the miners struck against the demand to fill six instead of five cars for a day's work. New men were employed, and rioting ensued, in which fire-arms were used. There were other important struggles between capital and labor. The strikes were generally unsuccessful. Twenty-five strikes occurred in 1875, and some of them were accompanied by violence. Owing to hard times wages were everywhere reduced, and the strikes against these reductions could not but end in failure. There was no improvement of the situation in 1876, during which year twenty-one strikes occurred. From 1873 to 1876 strikes were especially numerous in the states of Pennsylvania, Illinois, Indiana, Missouri, Maryland, Ohio, and New York. Great bitterness was evinced against trades unions, and men were "blacklisted" to an extent almost unequalled. Nevertheless, men everywhere formed new unions or reorganized their unions into assemblies of the Knights of Labor. In 1876 the different iron-workers' organizations were federated, forming the present great organization known as the Amalgamated Association.

In 1877 occurred the great railroad strikes. The trouble began on the Baltimore and Ohio railroad at Martinsburg, W. Va., the immediate cause being a 10 per-cent. reduction. There were, however, other grievances, such as irregular employment, delay in payment, and assessment of costs of accidents. There was rioting, destruction of property, and loss of life, at Martinsburg, Baltimore, Pittsburgh, and other places. The State militia at Martinsburg and Pittsburgh affiliated with the strikers and refused to fire upon them, and United States troops had to be ordered from the eastern garrisons. In Cincinnati, Toledo, and St. Louis mobs succeeded in closing most of the mills and factories. In Chicago the Socialists made a formidable demonstration, and in many cities in New York mobs had to be dispersed by the State militia. There are no figures obtainable as to the number of men thrown out of employment in the aggregate by these strikes, nor of the total value of property destroyed in the resulting riots ; it has been estimated, however, that the damage which was inflicted by the mob at Pittsburgh alone was $5,000,000. Besides these railroad strikes there occurred in 1877 about forty other strikes in various industries. For 1878 about thirty different important strikes are recorded, and for 1879 about forty. There were also some lockouts. Strikes under the auspices of the Amalgamated Association of Iron and Steel Workers multiplied during 1878 and 1879. Some were for higher wages and some against a species of coöperation favored by the companies, the principal condition of which was that the men should leave in the hands of the companies the first four weeks' wages and 25 per cent. of all wages earned thereafter, the same to be paid at the end of the year, if the profits should justify such payment.

Since 1880 the government has issued an annual tabulated report of labor disturbances. The total number of strikes and lockouts for 1880 is 762. Some of these strikes involved many different establishments. 304 strikes occurred in Pennsylvania, 104 in New York, and 93 in Ohio. The mechanical and manufacturing industries furnished 524 of the disputes, and mining 182. The large number of strikes reported for 1880 indicates the fragmentary character of the information obtained for former years. It is probable that some at least of the years prior to 1880 were as fruitful in respect of labor troubles as was that year.

The number of strikes for 1881 is 471, and the number of establishments involved is 2928. In 1881 the federation of organized trades and unions was formed, its relation to the different trades unions being analogous to that subsisting between local bodies and central labor unions in the cities. In nearly every one of our chief cities there is a central labor union to which the local unions send delegates. In 1882 454 strikes occurred, involving 2015 establishments. In 1883 478 strikes were recorded, and the number of establishments involved was 2759. In 1883 occurred the great telegraphers' strike, which involved the majority of the commercial telegraph operators of the country. In 1884 443 strikes occurred involving 2367 establishments, and in 1885 645 strikes, involving 2284 establishments. In 1885 the coal miners formed a national federation. The number of strikes for 1886 was 1411 and the number of establishments involved 9861.

In the spring of 1885 the shopmen on the Missouri Pacific railway struck for the restoration of the wages paid in 1884. Four thousand men were involved, and during the continuance of the strike freight traffic was virtually suspended. The governors of Missouri and Kansas brought about a settlement of the troubles favorable to the strikers, who had the sympathy of the public on their side. The big railroad strike of 1886 began at Marshall, Tex., on the Texas and Pacific. A foreman was discharged for alleged incompetency, but as he was a Knight of Labor, the Knights inaugurated the great strike, claiming that the discharge was in violation of a previous agreement, and alleging other violations. On March 1 the shopmen, trackmen, etc., on the Texas and Pacific were called out, and on March 6 the men on the Missouri Pacific and leased lines were also called out. During the entire month of March all freight traffic was virtually suspended on the roads, and about 10,000 men were out of work. On March 28 the strike was declared off, but the companies refusing to treat with the men except as individuals, the order terminating the strike was revoked. In May the strike was again declared off, and unconditionally. Traffic, however, had been resumed before this under police protection, as many of the strikers had returned to work and new men had been engaged. This failure marks the beginning of the decay and the dissolution of the order of the Knights of Labor.

Taking the years from 1881 to 1886 inclusive, an analysis shows that 22,304 establishments were involved in strikes during the whole period, while 2214 had lockouts. The number of employés involved for the period was 1,323,203. The loss to the strikers was $51,814,732, and the loss to workmen through lockouts was $8,157,717. The employers' loss through strikes was $30,701,553 and through lockouts, $3,462,261.

The present construction of the doctrine of conspiracy is shown by an opinion delivered in 1888 by a judge of the New York supreme court. No doubt, he said, exists of the right of workmen to seek by all possible means an increase of wages, and all combinations which have that end in view, if not distinguished by violence or threats, cannot be condemned. The attempt of a "scab" and disorganizer to reduce wages should not, however, invoke the disasters of a strike. But if this must be done to perfect an organization or to hold it together firmly, it should end there, and should not resolve itself into a determination that the objectionable person, the scab, should be prevented from working for the support of his family within a given district, large or small.

From a study of the facts and figures relating to strikes and lockouts one rises with a firm conviction that these phenomena cannot be due to the subterranean plotting of a few selfish agitators, but must be regarded as one of the inevitable results of the system of free industry. It is as natural for the employer to seek to increase his profits in every legitimate economic way as it is for the workman to try to raise the market value of his labor. Whatever there is of evil in these conflicts between labor and capital tends to right itself, and under freer competition and less legislative regulation the strikes would diminish in number and improve in character. There are undoubtedly better ways than strikes to settle disputes, and self-interest is sure to discover and prefer the better ways. It is proper and necessary for the law to intervene when justice is violated, but it is not the duty or business of the law to discourage strikes in general. Business experience and interests should be allowed to determine the course of strikes. Government interference can only breed violence and divert the question into socialistic channels. Of late nearly every great strike may justly be said to have been an attack on the whole system of private property and competitive industry; and for this radical change of attitude on the part of the laboring masses legislation is chiefly responsible. "The remedy for the evils growing out of liberty is greater liberty," has been said; and this proposition may be applied to the industrial relations as well as to the political.

While it is true, on the one hand, that since 1886 the labor organizations have lost considerable ground, and that to-day even the most powerful unions find it impossible to enforce their demands by means of great strikes and "tie-ups," it is also true that the dangers and evils of collisions between employers and workmen are greater now than they ever were. The old trades-unionist had no sympathy whatever with state socialistic notions and was careful to disavow his responsibility for revolutionary attacks on the fundamental principles of industrial society. He merely insisted on what seemed to him "a fair day's wage for a fair day's work," and repudiated the radical programme of expropriation and abolition of private enterprise. He had no quarrel with free competition, property, profits, or the right of the employer to be his own master. He claimed the right to strike, to boycott, and to act in concert with his fellows; but he did not theoretically go any greater length. He occasionally resorted to violence, but this was done in the heat and excitement of struggle, and no justification was ever attempted of any destruction of property or interference with liberty. To-day, however, a totally different spirit pervades and controls the world of organized labor. The "new unionism" has virtually espoused the state socialistic doctrine that free competition and private enterprise are incompatible with the interests of labor, and strikes are regarded as the preliminary encounters which hasten the inevitable final conflict between capital and labor. The attitude of the Homestead strikers and their socialist sympathizers in and out of Congress is still fresh in the public mind. Every failure, defeat, and disappointment necessarily tends to drive the workmen into more and more extreme positions. The more desperate the situation, the greater the danger of violence and reckless disregard of bounds set by justice or law. It behooves us therefore to give earnest consideration to the "labor problem," and, by securing to labor its due, deprive it of all excuse for aggression. To avert state socialism, it is necessary to establish economic justice and equal freedom.

THE INCREASING DIFFICULTY OF GETTING GOLD.

By T. A. Rickard, E. M.

THE gold-seeker has ever been the subject of romance, but even the tale of the Golden Fleece and the Dragon can be interpreted in a manner more practical than poetic. It is probable that the fleece of the ram was used in catching the gold of the river Colchis just as we now employ woolen blankets for the same purpose. The story of the dragon was intended to keep Jason and his followers from trespassing upon rich diggings. Thus a weak romance often has hidden a stern reality, even up to the time when the later Argonauts swept over the snowy ranges of the Sierras and penetrated the primeval silence of the Australian bush. But the mists of romance are vanishing. It is only in keeping with the hard, matter-of-fact tendencies of the times that the gold-digger should be stripped of the false poetry which has hitherto clothed him. He stands before us no longer as the amiable hero of a Bret Harte idyll, but as a man, strong and vigorous, searching for wealth with an intensity of concentrated purpose which knows no obstacle and is careless of all danger.

The romance of mining has been its undoing. It is time to tear away the remaining rags of tinsel that hide the true nature of that great industry. The winning of gold, like any other form of human industry, requires the exercise of judgment, science, and common sense,—most of all common sense.

Gold is now rarely got by digging at grass-roots. The discoveries that startled the world in the middle of the century were the product of ages of silent work. Consider the vast period of time which had been required to gather the metal from a state of wide dissemination and to collect it in the places where the miner found it. The frost had shivered the hard rock, the wind and rain had swept the broken fragments into the rivulet, the rivulet had delivered its golden tribute to the rapid flowing river whose waters laid it down in some quiet bend or behind some rocky bar. Nor was this all. Nature, to avoid the undoing of her labor, afterwards covered the golden gravels as with a sheet by flows of basaltic lava which prevented them from being swept away. Cold and heat, wind and wave, the waters above and the waters under the earth, had been patiently sowing the seed of a harvest which man, the heir of all the ages, was destined to gather.

The great ingathering of the harvest, which began in California in 1848, and in Australia in 1851, was the result of the working of geological agencies during periods of a length to which the time of a generation is as a dewdrop to the sea.

In the days of the first discoveries the pioneers had no thought of the possible exhaustion of the shallow alluvium. The "forty-niners" saw no limit to the golden mosaic which seemed to pave the bed of every mountain stream. Time has told its tale, however, and we now know something of the essentially local character of even the largest deposits of the precious metal. Since the early "fifties" the exploration of unknown regions has, thanks to the hunger for gold, been carried on with intense activity and startling rapidity. The map of the world has been almost filled in. A horde of gold-seekers has restlessly wandered from land to land until it is very improbable that another Tuba or a second Ballarat will soon be found. The mining-fields will be opened up at intervals and in places far apart, new depositories of ore will be uncovered, but it is improbable that, though perhaps extensive and sometimes rich, they will be of that easily-won character which distinguished the shallow gravels of California and Australia. Gold will be won in the future with more toil and expense.

Two facts must be fully recognized. The enormous yield of the few years succeeding 1850 was obtained from surface deposits and shallow gravels, while the production of to-day is obtained for the most part from vein-mining, the gold being torn from the heart of the rocks at depths extending at times to more than a half-mile from sunlight. The past was the era of gravel-digging; the future will be worked by quartz-mining.

In order to be able to weigh the full importance of these facts a reference to the statistics of production * will be required. The world's production of gold has been subject to many fluctuations. No reliable figures are available before the year succeeding the discovery of the new world. From 1493 to 1520 the mean annual production was 5800 kilograms, worth about $3,854,680. For the next century and a half there was a steady increase, so that from 1741 to 1760 the average annual yield had augmented to 24,610 kilo-

* The figures quoted in this paper are for the most part obtained from "The Mineral Industry," by Mr. R. P. Rothwell; the others are obtained from the reports of the director of the United States mint.

grams, worth about $16,456,150. Then came a decrease. In 1821-30 the production averaged only 14,216 kilograms (or $9,448,055) per annum. Again the tide turned. It flowed until it reached high water mark when gold was discovered in California and Australia. In 1831-40 the mean annual output was 20,289 kilograms (or $13,484,353). In 1841-50 it increased to 59,759 kilograms (or $36,393,598). Then the new worlds of the west and of the south opened their treasure-vaults and the production leaped to an annual average of 199,388 kilograms (or $132,516,056) in the years 1850-55. The highest yield was in 1853, when the world's production had a money value of over $155,000,000. Since that time the yield has fluctuated with a tendency to decrease until 1890, when a gradual increase became again manifest. The old world had come to redress the balance of the new. South Africa began to be an important producer. The yield has been :

	Kilograms.	Value.
In 1889	185,809	$123,489,000
In 1890	170,248	113,149,260
In 1891	181,339	120,518,849
In 1892	196,814	130,816,227

It is well to note that these figures, compiled at the United States mint, have undergone important changes. There has been a great deal of uncertainty as to the actual production of China. Since the publication of the report for 1891 the director of the mint has decided to drop China entirely from the list of gold-producing countries. This has diminished the production for 1890 and 1891 from $120,475,300 and $125,299,700 respectively to the figures above quoted.

In order to understand the full significance of the figures which have been given, it will be necessary to find out to what regions we owe our gold supply and then to follow up this inquiry by endeavoring to determine the conditions under which it is obtained. The current gold production of the world comes for the most part from four countries. In 1892 the distribution was :

	Kilograms.	Value.
Australasia	50,964	$33,870,800
United States	49,654	33,000,000
*Russia	38,822	25,801,645
South Africa	33,207	22,069,578
Other countries	27,560	18,330,249

*The figures of Russia's production are later than those of the director of the mint and are taken from the *Engineering and Mining Journal*, July 29, 1893. The corrected output of the world for 1892 will therefore exceed that given in the mint report by more than two millions.

Gold was first discovered in Australasia on February 12, 1851, by E. H. Hargraves, at Lewis Ponds, New South Wales. In the following July the first find was made in Victoria. Since that date Australasia has produced, up to the end of 1892, no less than 90,-715,960 ounces of gold, valued at $1,750,000,000. Of this total the colony of Victoria has contributed no less than 58,101,430 ounces, valued at $1,150,000,000. In 1892 three of the four leading colonies* (no figures for New Zealand are just now available) contributed :

	Yield in Ounces.	Value.
Victoria	654,456	$13,481,793
Queensland	615,558	12,680,494
New South Wales	156,820	2,231,522

In Australasia, as we have seen, two-thirds of the yield has come from the colony of Victoria. In the year of discovery (1851) the production was 145,137 ounces. From 1852 to 1860 the yield exceeded 2,000,000 ounces per annum, reaching a maximum in 1853, when it was 3,150,021, worth about $63,000,000. An enormous output was maintained until 1856, when a gradual decline commenced and continued until the minimum was reached, in 1891, when the yield was only 576,399 ounces. During the last four years the revival of mining at Bendigo has tended to arrest the decline so that last year the production of Victoria increased to 654,456 ounces. From three millions to less than two-thirds of a million ounces is a big falling off. To what is it due? Let the reply come from the royal commission appointed by the government of the colony "to inquire into and report as to the best mode in which assistance could be rendered to develop the auriferous resources of the colony." This commission reported on September 30, 1891, that the gradual decline in the gold yield was to be attributed "to the working out of the shallow but rich alluvium in the early days, first by armies of eager, energetic, industrious, and intelligent men from all parts of the world, and afterwards by large numbers of Chinese, who reworked the abandoned gold-fields ; to the difficulties and expense of quartz-mining, and the limited employment that could be given owing to lack of capital ; to the spread of agricultural settlement, and, as subsidiary causes, to the shepherding† of mining-lands and the gambling in shares."

*These figures are obtained from the annual report of the secretary for mines of Victoria, for the year 1892.

†Mining claims are leased by the government on condition that work is carried on continuously except for good cause shown ; the avoidance of the fulfilment of these conditions is called "shepherding."

This explanation undoubtedly is correct. The two important factors in the decline are the working out of the shallow alluvium and the expense of vein-mining. Figures will prove it. Until 1856 there was no quartz- or vein-mining in Victoria. Although the rich croppings of the reefs of Bendigo and Ballarat had previously been broken and crushed by simple contrivances, the industry of vein-mining in Australia may be said to have had its beginning with the erection of the Port Phillip stamp-mill at Clunes in May, 1857. The year which marked the commencement of quartz-mining also marked the beginning of a decline in the gold yield and the first indications of a near exhaustion of the shallow alluvium. The yield from the gravels decreased as the production from the quartz-veins increased. Finally the latter exceeded the former. In 1889 the ratio of alluvial to quartz gold was as 37 to 63. The decline of the former continues. In 1890 the ratio was 35:65 ; in 1891 it was 32:68, and in 1892 it was 31:69. In 1892 the yield from alluvium alone amounted to 201,958 ounces, out of a total of 654,456. In 1851 the yield was 3,150,021 ounces, all of alluvial origin.

The question arises, will the quartz-lodes redress the balance ? In replying one point must not be overlooked : of the present yield from alluvium fully half comes not from shallow placers but from deep leads, old river-beds covered by flows of basalt. The principal mines of this kind, like the Madame Berry at Creswick, are becoming exhausted and no new ones of equal productiveness have been found. The output from the quartz-reefs of the mines of Bendigo and Ballarat will probably continue to increase. There certainly is no sign of any approaching exhaustion, but the gold obtained at depths of from 1000 to 3000 feet is won with a difficulty and at an expense to which the working of the first found alluvium was mere child's play.

Let us turn to the United States. The beginning of gold-mining in this country dates from 1829, when the placers of Georgia were uncovered. From 1792 to the end of 1847 the United States produced a total of 1,187,071 ounces, valued at $24,536,769. On January 19, 1848, Alexander Marshall found gold in California. From 1848 to 1892, inclusive, the United States has produced 94,105,181 ounces, valued at $1,945,156,180, of which California has contributed no less than $1,300,000,000. In 1892 the chief gold-producing States were :

	Yield in Ounces.	Value.
California	580,500	$12,000,000
Colorado	256,387	5,300,000
South Dakota	178,987	3,700,000
Montana	139,871	2,891,386
Idaho	83,271	1,721,364

Even to-day California produces three-eighths of the total production of this country. The greatest yield from that State occurred in 1851, when it was $81,294,700. The date of the maximum output coincided, as in the case of Victoria, with the inauguration of quartz-mining. The first stamp-mill was erected in Mariposa late in 1850, but it was in 1851 that serious work was first begun upon the lodes of Grass Valley and Amador. From 1851 to 1858 the production of California was maintained at a high level, but from 1858 to 1882 there was a steady decline. In 1882 the yield was worth $16,800,000; in the following year it fell suddenly to $14,120,000, and in 1885 it had declined to $12,700,000. This marked decrease was due to the general cessation of hydraulic-mining due to what is known as "débris legislation." Since 1885 the production has not varied much. In 1892 it consisted of 580,500 ounces, worth $12,200,000, as estimated by the director of the mint.

It is time now to inquire into the relative production from the alluvial gravels and from the quartz-lodes. In 1851 the entire product, $81,294,700, came from shallow alluvium. In 1881 the yield of California was $18,200,000, and about one-half was of alluvial origin. In 1892 hardly 10 per cent. of the production was derived from the gravels. The obstacles raised to the carrying on of hydraulic-mining, due to the filling of the river channels with tailings from the mines, caused an immediate diminution of the yield of from $6,000,000 or more. This was in the years 1882-84. All hydraulic- and placer-mining, however, did not cease at that time. In the northern parts of the State several rivers have been declared unnavigable and the country tributary to them is therefore exempt from débris legislation.

In California, as in Victoria, the shallow rich alluvium has been for the most part exhausted. There remain the much less rich but far more extensive bodies of gravel laid down in ancient river-beds. The value of these has been much exaggerated. Statements have been made that upon the full resumption of hydraulic-mining the State of California would increase its yield by from $15,000,-

000 to $25,000,000 per annum. What can be done may best be judged from what has been done. When hydraulic-mining was stopped the output from this source was from $6,000,000 to $8,000,000. When it is resumed the mines may contribute an amount equal to that of their former production. The full resumption of work at the hydraulic mines which were closed in 1882-89 will not, however, be lightly undertaken. The plant of most of them has largely gone to ruin. The capital required to recommence operations on the former scale will be very large. The margin between profit and loss is very small.

Vein-mining in California is still in its early youth. It is destined to a future of great usefulness and steady production, but it cannot, so far as we can now see, hope to redress the heavy diminution in the yield of gold caused by the rapid exhaustion of the more shallow deposits.

The third country in order of gold production is Russia, which has been a steady producer for the greater part of this century. Gold-mining may be said to date in Russia from the year 1745, when auriferous quartz was found at Ekaterinburg, in the Urals, and in the Altai. Nearly a century elapsed before the industry reached any great importance. In 1814 the production was 263 kilograms, worth $174,783. It did not increase much until 1822, when the total was 20,335 kilograms, worth $13,514,712. From the beginning of 1848 to the end of 1892 the total yield had a value of no less than $930,910,677. The highest production for any single year was in 1880,—namely, 43,273 kilograms, worth $28,759,860.

Gold-mining in the Russian empire is still in its early stage and the alluvium supplies the bulk of the yield. In 1892 the production was thus distributed: Oural district, 11,532 kilograms; Tomsk, 6891, and Irkoutsk, 20,399 kilograms. The Ural mountains have long been an important mining region and supply nearly all our platinum. Irkoutsk is near Lake Baikal, while Tomsk divides the distance from the Urals. Of the large amount contributed by the Irkoutsk district, which includes the vast area of eastern Siberia, no less than 18,714 kilograms were the product of private mines, as distinguished from those which are the property of the crown. In 1890, of the total yield of Russia, only 7 per cent. came from vein-mining. Mining, like politics, in the Russian empire, is wrapped in some obscurity which the new trans-Siberian railway will do much to remove. This colossal undertaking is making good progress; it will traverse the whole width of the Asiatic dominions of the czar and do much to lessen the costs, hindrances, and difficulties inseparable from mining when carried on at a distance of hundreds of miles from the source of supplies.

Africa has only recently resumed its place in the foremost rank of gold producing countries. The history of its first production in the dark continent would take us back to a time when Central Europe was a wilderness and America unknown. Nevertheless the region which constitutes nearly all the present output of South Africa is essentially a new mining district. It was in 1884 that the De Kaap was discovered, but the "banket reefs" of the Transvaal were not uncovered until the following year. The ancient diggings recently found in Mashona and Manica land have as yet more of historic than economic importance. The growth of gold-mining in the Transvaal is told by the following record of production:

	Yield in Ounces.	Value.
In 1887	43,155	$ 755,212
In 1890	494,817	8,434,486
In 1891	729,238	12,433,754
In 1892	1,210,862	21,190,085

The auriferous deposits of the Transvaal, more particularly those of the Witwatersrandt, are generally spoken of as "reefs," the colonial equivalent of "lodes" or "ledges." As a matter of geological fact these curious formations (locally called "banket") are conglomerates whose tilted position is their chief claim to be considered as quartz-lodes. From an economic point of view they certainly cannot be classed with alluvial deposits, since they are being exploited by methods exactly similar to those used in ordinary vein-mining.

Of their enormous extent, uniform richness, and comparative inexhaustibility we have heard much of late. Recent borings have indeed proved geological reasoning to be correct, and have indicated that this, the newest of the great gold-fields of the world, has an enormous extent, both in strike and in dip. The pioneer of 1849 will tell you, however, that he never dreamt that the placers of California could begin to become exhausted; yet within the time of his generation he saw that the cream could be skimmed. It is indeed true that the deposits of the Rand are entirely different in their character from those of California, and that we listen to the statements of men who have an experience and a knowledge undreamt of by the vigorous but ignorant pioneers of 1849. This is allowed, but on the other hand we must recognize that the conditions under which gold is won in 1893 in the country beyond the Vaal river are entirely dissimilar to those which obtained in 1853 on the Yuba. The gold of the former is got with far more difficulty. The yield per ton of ore averages about half an ounce at Johannesberg to-day ; it averaged perhaps ten times as much in California forty years ago. The quantity of gold won by two men, with a shovel, a pick, and a rocker, in the latter case, is obtained by ten men and ten stamps in the former. The capital of the early Californian consisted of his energy and a few simple tools, but the Anglo-American in South Africa must spend many thousands of dollars in developing an extensive mine and in equipping a ponderous mill.

The conclusion, therefore, is that while the new gold-mining regions of South Africa will very materially add to the production of the precious metal, yet the conditions under which it is there obtained are such that even at the present time, when no great depth has been attained and when the treatment of the ore has as yet offered no very serious difficulties, it is won at such an outlay of capital, labor, and supplies as to prevent any approximation to the conditions and results which marked the mining of the years 1851 to 1855 in California and Australia. What is true of this new district of the southern hemisphere is also true of the older mining regions of the world. A direct comparison between the cost of working shallow alluvium and the expense of the exploitation of a quartz lode, several hundred feet underground, is difficult to make. The great contrast between the two methods of working, however, is evident : the former requires, in comparison to the yield, but little labor and less capital ; the latter is an undertaking of a serious character, requiring the investment of much capital to commence operations and of more to continue them until they become profitable.

There are many regions where gold is known to occur in notable quantities, but under very unfavorable conditions. Extensive, and as yet comparatively untouched, deposits of auriferous gravel are known to exist in the deserts of western Australia, on the table-lands of Brazil, in the interior of Guiana, in the undeveloped regions of some of the Central American states, in the river-beds of Colombia and Uruguay, in the wilderness of Siberia, in the veldts of Central Africa, and in many other places scattered the world over. To predict a near exhaustion of the gold deposits of the globe would be foolish, but it is certainly true that the difficulty of the getting of gold is daily increasing.

ARCHITECTURE AS A PROFESSION.

By R. W. Gibson.

THE average professional man, fairly successful as a lawyer, physician, or architect, would perhaps find it difficult to explain why he followed his particular avocation. He might, even in admitting that he liked it, confess an opinion that he would have better succeeded in some other pursuit; that he could have been richer, or less hard-worked, or more healthy. Or, he might say frankly that he did not like it, but circumstances had thus arranged themselves and him, and he accepted the fact. Naturally the prosperous man would most often confess to a pleasure in his work, but whether that pleasure were the effect or the cause of the prosperity might still remain an open question in his own mind. His appreciation of his chosen career would certainly not be attributed by him to the pecuniary emoluments it afforded; for it has never been urged that any of the professions offer a tempting or easy highway to wealth. The professional man too often sees his schoolmate, who in earlier days stood many places below him on the class list, now amassing a fortune in a trade which he, the enthusiast, used to despise, and now marvels at. He sees his friend of later years presiding over a hundred employés, each one guiding a runnel of dollars to trickle into the president's river of prosperity. For himself he knows that all this is impossible. It is not merely remote; it is out of the question. A man can never hope to enrich himself in a profession as he might in commerce. On the contrary, he finds his own vaunted talents obliged after all to wait upon these reservoirs of opulence for their opportunity, for their very permission to move. Art and Science, Intellect and Genius, the handmaids of civilization, are in the end only handmaids, and are bidden and curbed and paid by those who control that circulating life blood of trade, money. And even if a wholesome disposition and a sufficiency of food keep him in a fairly contented frame of mind, he cannot but ask at times whether it is not as much satisfaction to employ artists as it is to be an artist.

The dependence of art and letters upon wealth is too old a fact to need demonstration, and the share of wealth allotted to their ministers is notoriously small. Why then do men of full understanding continue to accept the conditions, and practice any of the learned or artistic professions instead of the more profitable commercial callings? The answer lies in a principle of social economy, which, although it is elementary in its science and general in its terms, may be very useful to us in a particular application. Let us devote a few new words to this old principle and then apply the argument to the choice of a modern profession.

That man works to live is a truism. Indeed it is so true and so generally accepted that it is apt to be overlooked. The impulse to work has become in this industrial age almost an instinct. Men who are not compelled by hunger, or even less imperative desires, still work like squirrels hoarding nuts in a cage constantly supplied. But notwithstanding these exceptions the rule remains. We work to live.

The prime motive of all labor must then be admitted to be the pecuniary gains which purchase the necessaries and pleasures of life; and the earliest deduction from this argument must be that (other things equal) he who gains most is most to be emulated. But other things are not equal. It is self-evident that the enjoyment of what is gained is as great a factor in the question as its acquisition. Many occupations by their nature detract from the pleasure of life, some by demands upon the physical endurance, for which an age of mental rather than bodily cultivation does not fit all individuals, and some by being so engrossing or so monotonous that the higher faculties are discouraged. On the other hand, many occupations offer for such as are suited to them positive additions to the satisfaction of living, by their intellectual character and associations, gratification of ambition for power over others, for fame and public approval, and for that personal pleasure which usually attends the successful exercise of skill.

The ranks of the professions are without doubt filled with men to whom the advantages last named appeal more strongly than the pecuniary reward to be expected, and among them architecture holds a very high place. In recent years, indeed, so much has been accomplished by architects in the advancement of their art that it may also be said now to be foremost in popularity. Not by numerical test; there are not nearly so many architects as lawyers; but in popular appreciation it is as desirable a profession. Why?

Let us now apply our analysis of the complex motives which we found in a man's impulse to work and in his selection of the kind of work. The objects are, first, pecuniary gain; second, an agreeable way of life. Architecture is supposed to offer a very happy adjustment of these two elements, and there is no doubt that the supposition is supported by many facts within the range of ordinary observation. An architect in good practice earns an income which enables him to obtain all the necessaries and some of the luxuries of modern life. A man of fair ability and energy no doubt is usually able to fulfill and enrich his destiny with the love of wife and children, and even perhaps to save a few thousands to guard them from actual want, and to educate and equip the young ones fairly for the contest awaiting them. And perhaps a few architects—one here and one there—become well off according to a very moderate standard of wealth. But the popular opinion is sadly in error in ascribing to architects as a class the enjoyment of such fat fees and light labors as occasionally appears to be the case in a newspaper revelation. There may be some rich men who are architects, but they were not made rich by architecture. The biggest prizes in this profession do not equal in profit the great ones of medicine or the law, nor, when the onerous character of the work is considered, the brilliant successes of painting. But perhaps the differences in this regard are slight.

All the professions may be said to offer, to such as can reach their upper ranks, positions very like those imagined as normal by idealists. Bellamy and others have represented life somewhat as modern successful professional men live ; except that as a rule the amount of work done by these of to-day is far in excess of the ideal, and that the relative social position is overwhelmingly different in the presence of the money measure of greatness which rules to-day. There is to be found here, however, a compensating fact which carries sentiment into realities. The personnel of the profession includes very many men whose own energy has been their sole resource and whose success with even such limitations (as they seem to others) is satisfactory to them when weighed with other gratified desires. When these were enthusiastic recruits, the prospective ten thousand a year, which gleamed like a lighted beacon ahead, seemed, with the honor and fame attendant, almost as great a prize as a hundred thousand. And though the supposed beacon may prove a will-o'-the-wisp and the ten thousand never be reached, or when reached prove an inadequate stipend, some of the hopes are realized and much of the enthusiasm will find realities to justify it to such men as these. There are many indeed in each of the professions who cannot be called successful who yet manage to get along somehow, to make a living and to laugh once in a while. All this is well. Decadence may surely be expected when in any country the professions become accessible only to the wealthy, when expense deters education, or law-sustained barriers keep out the ambitious energy of the penniless student. Happily no such mischief threatens here. The schools and mysteries of law and medicine are free and accessible. In architecture indeed an opposite evil is to be overcome. Broadly speaking, there is no education to be purchased, there is no supply, and there is but little demand, because there are no barriers to separate the educated from the uneducated. It is true that at a very few places a very small number of young men study architecture after fashions more or less primitive, but they are so few and of such fashion that, compared with the great need, they are of no account. In one way they are important; they are the beginnings upon which better things must and doubtless will grow. The absence of schools and tests is a great factor in the development of American architecture. It is not without some secondary advantages. It is far better that there should be no school at all than that the school system of some European countries should prevail. Individuality, which is the basis of artistic progress, and which thrives in this country now, is easily crushed out by ponderous pedantry, and the independence of youth which dares and does so much among us will become timid when academies frown with authority as they grow old. The technical school, hitherto, has been so apt to put technique before all else that it will be hard to avoid the evil here. We can afford to make haste slowly. Another fact worth noting is, that in the absence of schools,—technical schools, I mean,—and in the presence of a critical public and a high degree of general education (which situation is fast approaching), there is much greater distinction for the fewer number of students who do achieve knowledge. This is not a permanent condition, nor could it be desirable to have it so, for natural competition rather than monopoly will always produce better results, if there be a competent judicial ability to distinguish them. But it is undoubtedly true to-day that a good architectural education is to an able man worth the more because of the difficulty of obtaining it This is one of those favoring opportunities attending the early ventures in any new field.

Architecture as to-day practiced in America is a new occupation. A generation ago there were almost no architects. Nearly all the men so calling themselves were self styled "practical" men, which usually meant mechanics, a little above their fellow-carpenters in achievements with the square and pencil, and content with an ability to plan one house like another, or, if a better house were wanted, to enlarge the plan and so make it bigger, which was their only conception of the possibility of improvement. All this has changed in the last thirty years. Architects of the new school are accustomed to think that they have brought about the advance and to congratulate themselves, and thank their leaders. But while the profession at large, and by its organized Institute, may have done something, it has been a trifle compared with the progress accomplished. The architects of to-day individually show remarkable energy and skill, and unsurpassed ability, but collectively they are as conservative and inert as the oldest of Europe's corporations. This, too, is a natural outcome of the past, or rather the absence of any past. The American Institute of Architects has a magnificent field and opportunity. It will some day be one of the most powerful and respected of national societies. Soon, when we have traditions of recognized value, they may stimulate us to a regard for the future ; that future which is never understood until it has gone. Now, perhaps, we are too busy. Then we shall have schools of architecture indeed,—great rivals in great cities whose differences will work more for unity than their agreements do now. Then we shall have a law defining some standard of technical knowledge and skill to justify the taking of the appellation of architect. Then we shall have a code by which a business man can ascertain what an architect is to do for him, and what he will not do. Then too we shall have a code of ethics for the guidance and governing, and sometimes the protection, of architects by themselves. Then we shall have in Government architecture the best work of the time, fit examples to educate and elevate the living generation and to stand as memorials of honor. Then we shall have an Institute of which every architect in the land will be a graduate and a member, not as a matter of dry duty, but because of evident benefit to him professionally, intellectually and morally. But all this is of the future, and the present is awaiting us.

The distinct advantage which architecture has gained in recent years, and the improved position the profession to-day enjoys in American cities, has arisen partly from the comparative newness of its work, but chiefly from the altogether new appreciation of Art and Science by the public, and more especially for business purposes. The design of the commercial buildings of to-day is beyond the capacity of the rule of thumb carpenter-architect of the past. Both the constructive science and the artistic motives are simply outside his mental horizon. A new order has arisen to meet a new demand. Not only architects, but a general advance and progress have placed the profession in its present honorable position. We can hardly say that capital is paying for fifteen-story offices or World's Fair palaces because there are architects competent to design them. It would seem more natural to suppose that the opportunity arose first, and the architects, like other quick-witted men, equipped themselves and supplied what was demanded.

An artistic awakening is an important point in the new era. The perception and understanding of beauty in architecture by so many people and such diversity of people render it paying to make a business building beautiful, since higher rents and more prosperous tenants come with attractive expression. This is what has kept the modern giants of building construction in the hands of architects and out of the hands of engineers. Science is not any more self-sufficient than art. The architect has not cultivated Art to the exclusion of Science. If the engineer had been equally wise, if he had cultivated art, even to the extent that the circumstances demanded, who knows ? it might have been hard to draw a line between them.

One thing which modern architects have themselves wisely and nobly made for their profession is a clean reputation for sterling integrity beyond the example of the times, and this is the more commendable since we recall the slough of turpitude in which the carpenter-architects had submerged all their operations. Once in a while we may still run upon some foul spot, but the architect who elects to be honest no longer finds any difficulty. Not twice in five years will he be reminded of those illicit commissions and bribes and presents which formerly were a regular part of the system of business of every builder and material dealer.

In this profession good reputation is a stronghold. An architect has many duties almost judicial in their character ; and very much more than is commonly known of plain executive business no more artistic than produce dealing is. Compared with the other fine arts architecture enjoys a place among the things practically necessary. This is not to be despised. The intrusion of the element of utility which has so often led to a challenge of architecture's artistic status has also given her a position among the wealth producers, which painting and sculpture and poetry do not enjoy.

Whatever prestige may be lost from the ideal standpoint of an imaginative art in the modern elasticity of the term architecture, is practically made up in the general benefit and strengthening of its hold upon the public by more familiar use. It may be argued that even the loftier aims of architecture are assisted by those utilitarian works which, though mean in themselves, afford profit and bread and butter to the artist who must live.

The modern architect is of necessity so much of a business man that the fine art is almost in need of a new school of prophets. After all, how little of all we do really deserves the name of architecture as did the Grecian temple, the Roman triumphal arch, or the Gothic cathedral. Some does, but how little! And what delight it is to an architect, what a rare delight, when once in two years he finds himself absorbed in some real study of real architecture,—the fine art, and not the commercial science. An architect is supposed by some people to be always at this exalted and noble occupation. He only knows the nineteen days of figures and specifications and plan problems of the "pons asinorum" order, and of office and "job" management and routine, which await him for each day of art.

At the same time it may be noted that architecture, being a comprehensive profession, affords scope within its limits for great variety of talents. In its general practice there is so little definition, so much individuality, that success can be achieved by widely differing methods, and its specialized departments are so many that the poet and the engineer can each find some employment.

The profession of architecture, therefore, commands respect and draws recruits, not so much by promise of great gains as by the offer of an honorable, intellectual career,—one which permits of the cultivation of the refinements and higher pleasures of life, and at the same time promises an income sufficient for all actual needs and for a few superfluities. The respectable position in the esteem of the community undoubtedly is taken as one of the chief compensations for the arduous duties performed. It is a good sign of a wholesome civilization that it is so.

As viewed by the young man on the threshold of active life, Architecture appears in her most attractive aspect from her most flattering distance. The choice of a profession is a difficult matter and a somewhat uncertain one, whether made by the individual whose interests are at stake or by a guardian for him. In the former case defective knowledge is complicated with very positive notions and headstrong confidence ; in the latter, good judgment is often handicapped by doubts and anxieties. Probably, after all, chance, the mere accident of circumstances, decides as many of these questions as selection does, and decides about as well. If one adopts architecture as a profession, it had better be of his own free choice. He must be an enthusiastic student ; mere assent or willingness will count for nothing. He should commence actual work early in life, and study and gain experience at the same time, and then, with quick energy, executive ability, and tact—which are far more important than the " taste for drawing" and the dilletanti acquaintance with art which probably suggested his course— he will surely achieve something ; and if he develop that rare combination of true artistic feeling with the business qualities already quoted, then he will be the ideal modern architect.

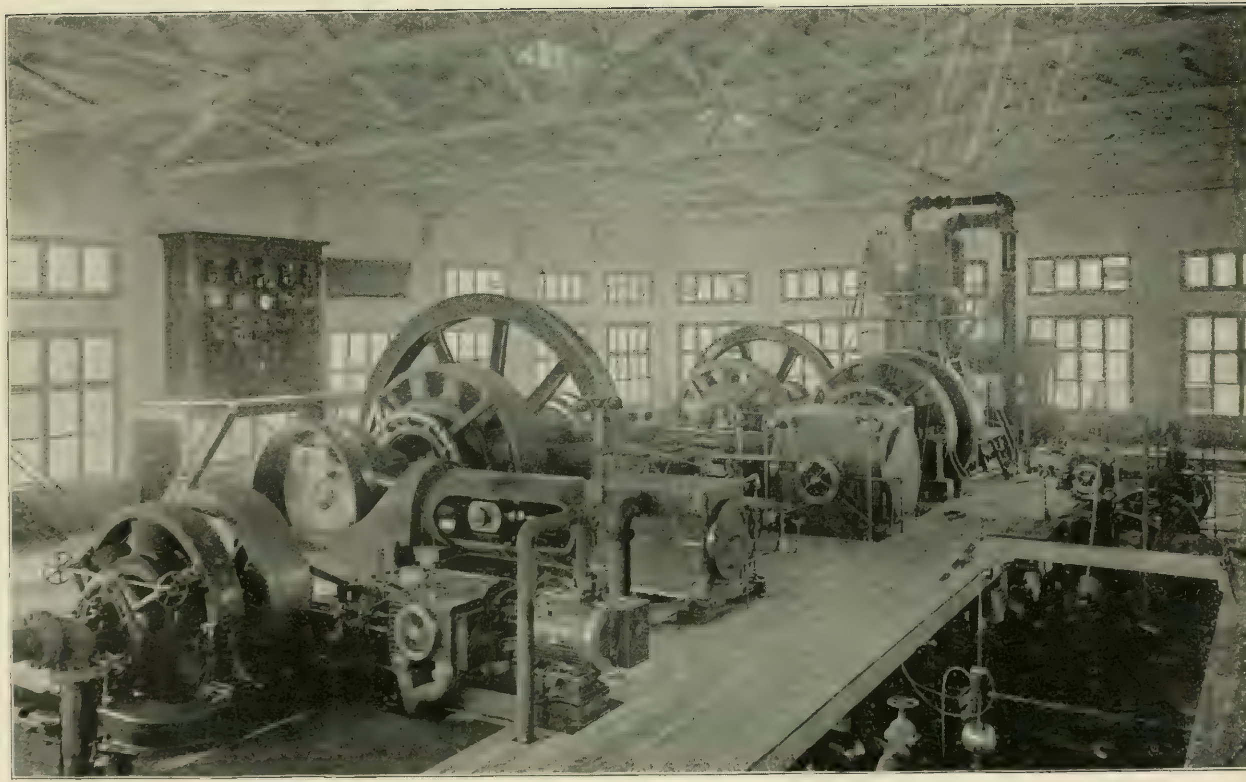
ELECTRIC POWER AT THE WORLD'S FAIR.

By Nelson W. Perry, E. M.

MACHINERY in motion has a charm that is lacking in the mechanism when at rest, yet to the student or specialist the latter may have a special interest akin to that which the corpse has for the anatomist. But the masses are not anatomists and are interested only in the moving wheels. Therefore, because much of the machinery in the Electricity building at the World's Fair was not in motion, many visitors criticised the display. "Separating the motive power from the tool," they said "is like divorcing the breath of life from the body." The exigencies of the case were such, however, that it would have been impracticable to furnish steam throughout the grounds, and it was properly confined in its uses to the Machinery Hall. Upon electricity therefore devolved the duty of transmitting power to the various buildings where it was to be used, and how well it performed the task there are millions who can attest.

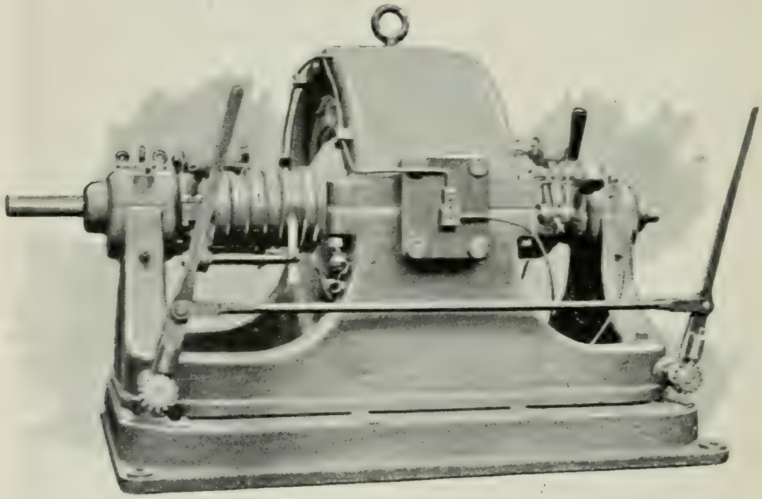
The fact that in some cases the energy thus transmitted had to undergo several transformations to adapt it to the desired use was a source of annoyance and expense which some exhibitors were unwilling to bear. The excessive demand for current which could be met by the supply only in part, and sometimes only at exorbitant charges for wiring and service, furnished a cause for many more idle wheels, but when it has been stated that all the machinery in motion at the Fair outside of Machinery Hall, as well as some of that within, was moved through the agency of electricity, enough has been said to indicate in a general way the extent to which it was thus used. Two exceptions must be made, however, to the statement regarding power outside of Machinery Hall: the power-house of the Intramural railway had its own boiler and engine-plant, and a portion of the power in the Mining building was furnished direct by steam.

Exactly how much energy was transmitted electrically for power purposes it is impossible to tell, but as a basis for an estimate it may be mentioned that in the great power-plant in Machinery Hall the generators catalogued on page 332 were employed for power purposes alone :



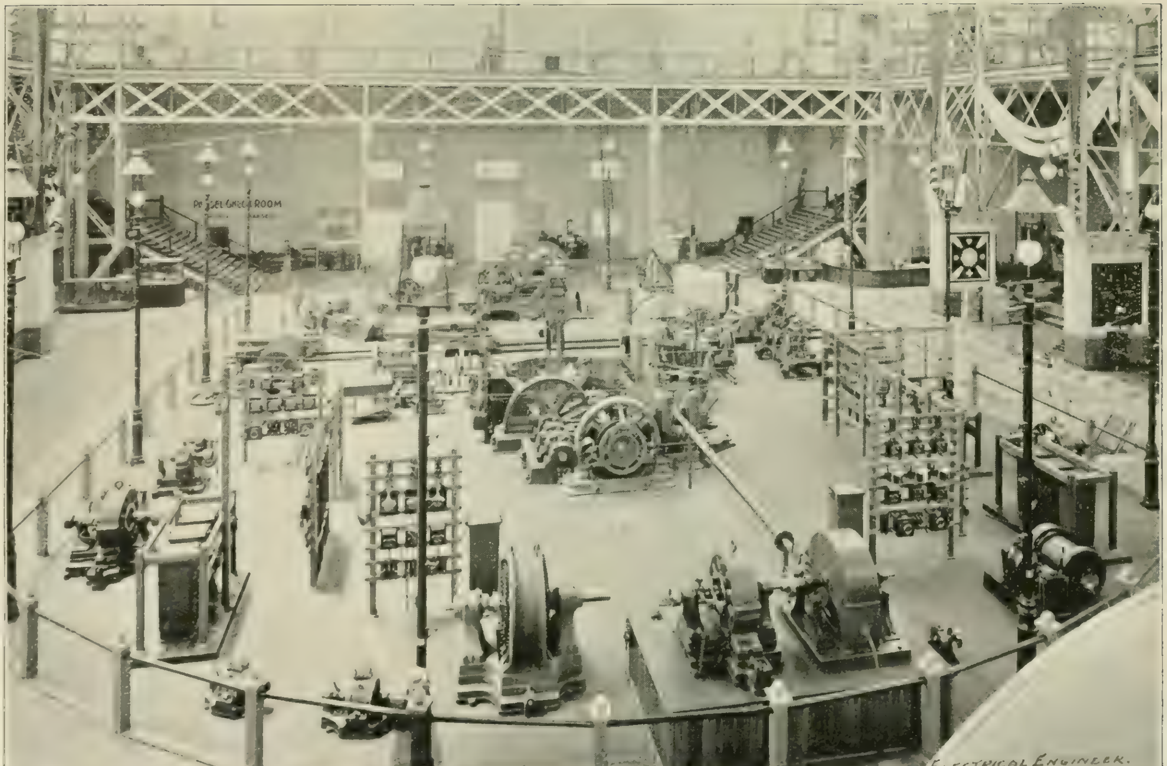
INTRAMURAL RAILWAY POWER-PLANT AT THE WORLD'S FAIR.

Makers.	No. of Generators.	Kilowatts.	Voltage.	Total Kilowatts.
Exposition :				
Mather	2	225	550	450
Mather	2	120	550	240
C & C	4	80	550	320
C & C	2	80	250	160
Eddy	4	186½	550	746
Westinghouse	1	373	550	373
Exhibitors :				
National	1	80	500	80
Jenney	1	40	500	40
Western Electric	2	137½	250	275
Wood	1	500	550	120
Total kilowatts				2,804
Capacity of Intramural power-plant				3,700
Grand total, kilowatts				6,504



TESLA TWO-PHASE MOTOR AND MOTOR TRANSFORMER.

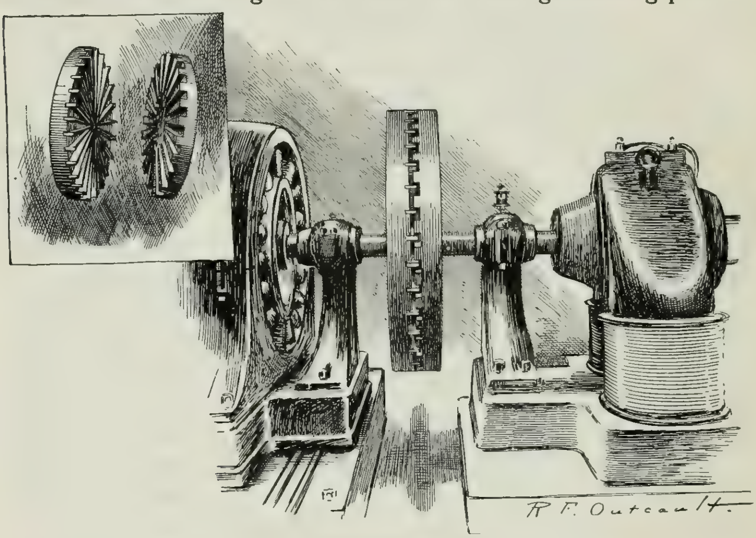
To this may properly be added the power generated more especially for lighting purposes, but which was employed in part by exhibitors or concessionaires for other purposes, and here is where the figures may become uncertain. As an illustration may be cited the four 150-kilowatt Edison generators primarily intended to supply current to the electrical fountains, but which after 10 o'clock at night were employed to charge the storage-batteries in the electric launches. There were fifty-eight of these launches, each equipped with a 4-horse-power motor. The Westinghouse com-



THREE-PHASE POWER-TRANSMISSION PLANT OF THE GENERAL ELECTRIC COMPANY.

pany used two of their single-phase lighting circuits to supply current to their polyphase power-plant, the central figure of their display in Electricity building, and other lighting as well as power currents were transformed by other exhibitors for power purposes, so that the actual horse-power of motors in operation at the Fair was considerably in excess of that indicated by the table. Certainly the rated capacity of electric machinery actually doing work at the Fair did not fall far short of 9000 horse-power, and the work performed embraced almost every variety known to the arts.

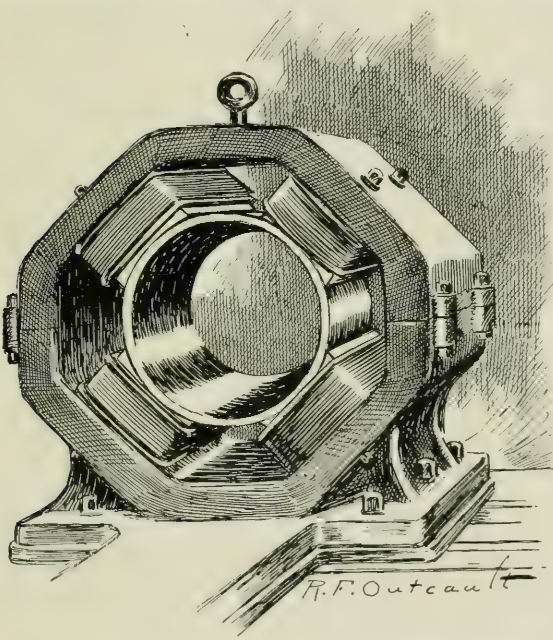
Owing to the fact that no steam was permitted in the Electricity building, all generators there shown in operation were driven by electric motors deriving current from the main generating plant in



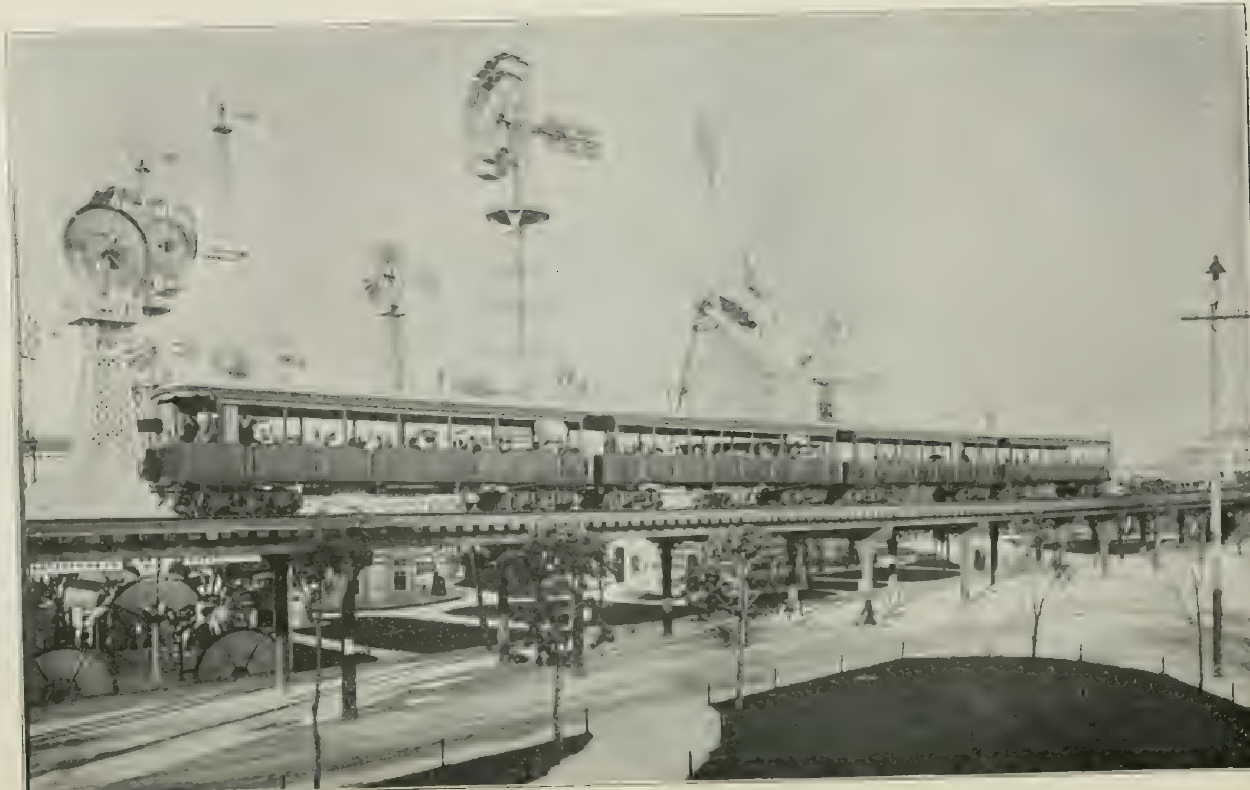
CLUTCH, OR COUPLING, IN DETAIL.

Machinery Hall, and these generators, in order to give them a load, not infrequently supplied current to other motors, besides furnishing the individual lighting supply of the various exhibitors. In this way such an exhibit became a subordinate central-station, itself operated by electricity, and which, in the cases of the Western Electric Co. and the Fort Wayne Electric Co., supplied current for power and light at a stipulated rate to other exhibitors. All of the direct-current incandescent lighting in Electricity building, as well as a considerable portion of the alternating-current incandescent and direct-current arc-lighting of individual exhibitors, was thus provided, constituting this by long odds the most extensive illustration on a practical commercial scale of the principle of the correlation and conservation of energy.

It seems a little strange that this fundamental law of nature should have been first discovered in the relation between mechanical work and heat, for while the most superficial observation might have taught that mechanical work was always accompanied by heat, it was not so apparent that there could possibly be any definite relation between the two. Therefore when Dr. Julius Robert Mayer asserted, in 1842, that there was a connection between the two, there were few who regarded it as more than an idle assertion. It was not until a few years later, when Joule demonstrated this relation, and still later, when Carnot enunciated the principle of the reversibility of the heat engine, that the law of the correlation and conservation of forces received recognition. According to Carnot's principle, it was theoretically possible to convert mechanical work into heat and by utilizing that resulting heat perform the same amount of mechanical work again, thus completing the cycle. This having become an accepted dogma, it was not much of a step to conceive that other cycles might be possible. To my mind the greatest object lesson of modern times has been that furnished by the facility with which electricity—more especially in the form of alternating currents—lends itself to the extension of the radius of cyclic changes. To me the most interesting lessons of the World's Columbian Exposition were those which were taught by the exhibits showing a few of the possibilities in this line.



FIELD-MAGNETS WITH POLAR RING, IN THE GERMAN EXHIBIT.



A VIEW OF THE INTRAMURAL ELECTRIC RAILWAY.

When, in 1891, the experiment was tried of transmitting power derived from the falls of the Neckar to Frankfort by electrical means, crowds flocked to see the falls pumping water after their energy had passed through a cycle of six changes. To be sure, the problems of chief interest to engineers were those of insulation against high pressures and the practicability of the three-phased current in power transmissions, then first prominently brought forward, but the principle upon which these problems ultimately depended was that first enunciated by Joule and Carnot.

It will be remembered that in the Lauffen-Frankfort experiment some 300 horse-power were transmitted a distance of 108 miles at 30,000 volts with an efficiency in transmission of about 70 per cent. and utilized at the Frankfort exhibition in part in lighting a bank of lights and in pumping water for an artificial waterfall. This experiment was epoch-making and has lent an unusual interest to the methods there employed. One of the most interesting power exhibits at Chicago, therefore, was that of the Allgemeine Electricitäts-Gesellschaft, the company which built and installed the transmission plant above referred to. In this exhibit were shown all the parts involved in the experiment, including the three-phased generator, step-up and step-down transformers, and three-phased motors. The machines shown were not exact duplicates of those originally employed, but embraced such improvements as later experience had suggested.

The foreign displays of electrical apparatus were looked forward to by American electricians with the keenest interest, as it was hoped that they would abundantly illustrate electrical practice, so far as it might be said to be typical, of competing companies abroad, in order that a comparison might be drawn between their machinery and our own. These anticipations, so far as generators and motors were concerned, were only fulfilled partially by Germany alone. England showed absolutely nothing, and France only a few generators, alternating current and direct, which performed no functions of a useful or instructive nature.

The two great houses of Germany—Siemens & Halske and the Algemeine Electricitäts-Gesellschaft—had interesting though small displays. The latter was especially interesting, not only for the reason already assigned, but because it contained several features entirely new to this country. One of these novelties was the adoption of what has been termed the "polar ring" for the fields of direct-current motors and generators. This consists of a cylinder of soft iron about an inch thick, enveloping the armature and connecting the pole-pieces of the field magnets. This was claimed to have advantages in prevention of sparking, for which purpose it was employed, which more than compensated for the magnetic short-circuiting which it must inevitably have produced.

This polar ring is strongly advocated by Dobrowolski, to whom I believe it is due, but it requires great effort on our part to believe the remedy is not worse than the disease. Certain types of field magnets have heretofore been so universally condemned by electricians simply because their shape has been such as to conduce to magnetic leakage that they have almost, if not quite, disappeared from the market. A deliberate short-circuiting of the magnetic field such as was illustrated in these machines was therefore astonishing, especially in view of the fact that sparking has been remedied in what would seem to be more rational and more economical ways. But *any* remedy is expensive that does not alleviate the disease, if one has to pay for the prescription, and I believe this is an expensive remedy, both because we pay for it in the lines of force short-circuited through the polar ring and because these machines *do* spark quite as much as well-constructed machines not employing the polar ring.

Another novelty in this exhibit which had real merit was the flexible coupling for directly connecting two shafts in approximate alignment, which consisted of two heavy iron disks, upon the face of one of which were a series of radial slots and upon the face of the other a similar series of brush-like rays of a number of thicknesses of thin sheet-iron, so arranged as to take into the slots on the opposite disk. Considerable play is allowed, permitting the two disks to gear easily, even if their shafts be perceptibly out of alignment, and the flexibility of the brushes is such as to take up the sudden strains, if moderate, or to permit them to slip a cog or two if excessive.

Siemens & Halske also showed three-phase motors and transformers. Of the latter there were two of 50,000 watts capacity each. In these air alone was used as insulation.

Until recently it has been urged by some practical men as an argument against the adoption of electricity in their business that, although it might accomplish some things better than agencies already in use, it was not sufficiently elastic to accomplish *all*, and that its adoption only meant an additional plant capable of doing one or two things a little better than existing plants, making of electricity a luxury. This was undoubtedly true, and in no direction more so than in the field of mining. For this reason the application of electricity in mining has not kept pace with its applications in other industries.

The two largest electrical companies of America made displays side by side which must forever remove from the popular mind all idea of the lack of flexibility of electricity. The electrical exhibit at the World's Fair would have been a marked success had nothing else been shown than what were called "the transmission of power" schemes of the General Electric Company and of the Westinghouse Electric and Manufacturing Company. These two rivals presented each its own choice of methods—both well known to the electrical fraternity in each of their several parts, but neither of them ever before so completely illustrated on a working commercial scale. Additional significance was given to these two displays because it was generally believed that they represented between them, in all essentials, the system that would be employed in the Niagara Falls transmission-plant.

The General Electric Company followed the lines of the Frankfort-Lauffen experiment in so far as it employed the three-phase system, while the Westinghouse company employed the two-phase or Tesla system, but in each the most prominent feature was the flexibility of the system in hand. Each of these displays will be best illustrated by following the current from its point of entrance to the exhibit through its various transformations and translating devices which were selected so as to illustrate how, from a single source, energy could be transmitted and distributed on a large commercial scale for almost every conceivable practical use. Both of these exhibits assumed a waterfall as the source of energy, but they obtained their water-power in different ways. The General Electric Company employed a deep-mine triplex pump capable of raising water against a head of 650 feet, to furnish the water-power. This was operated by a 100 horse-power 220-volt direct-current motor, receiving current from Machinery Hall by the Edison three-wire system. The water from the pump was directed against the buckets of a Pelton water-wheel, which was directly connected with a 35-kilowatt three-phase generator, whence the currents passed to step-up transformers having a ratio of 20 to 1. They were thence transmitted at the higher potential on three No. 18 wires a short distance to what was called the Mining exhibit. Here they were transformed down again to 110 volts and carried to a distributing switchboard whence lighting- and motor-circuits radiated. On one of the former a bank of incandescent lamps constituted the load ; on another, arc-lamps, and on a third, a series of small three-phased motors were operated, thus repeating all the links in the chain which bound Lauffen and Frankfort in the memorable experiments of 1891. The extreme potentials, long distance, and volume of power, however, were lacking.

The General Electric Company also showed both here and on the battle ship *Illinois* motor-transformers, the latter being fed from the Intramural railway trolley-wire, transforming the 500-volt current down to one of 80 volts. The secondary armature of this was compounded for the usual percentage of loss. As the current was to be used for lighting purposes, which required that its voltage be maintained constant between very narrow limits, it became a very pretty problem to compensate for the wide fluctuation in the primary. This was partially accomplished by commutating the field windings on the motor and further by inserting in parallel with the shunt winding of the generator a storage-battery which absorbed energy when the E. M. F. was too high, and gave it out when it was below normal.

The Westinghouse transmission-plant received its energy from two alternating currents in quadrature, derived from the two armatures of one of their 750-kilowatt generators in Machinery Hall. These currents at 2000 volts and 7200 alternations were transformed down to 200 volts in the building and then led to a 500-horse-power two-phase Tesla alternating current motor. Upon the same shaft, to simulate a prime mover, was a Pelton water-wheel, but this was merely a dummy operated by, instead of driving the motor. This latter, however, drove a 500-horse-power alternating-current generator. On one side of this generator, from four collecting rings, there were taken two alternating currents in quadrature with each other of about 4000 alternations and at a potential of 360 volts. On the other side was a direct-current commutator connected with the same winding, from which could be delivered a direct current at 500 volts. All three of these circuits were led to appropriate terminals on a switchboard for the distribution and control of their currents. By the alternating currents there was operated a 500-horse-power two-phase Tesla motor similar to the generator just described. This was also connected as a rotary transformer.

By means of special field connections this could be started as a two-phase motor, and after it had gained its speed, by means of a switch, changed over to a self-exciting synchronous motor. As a motor it was employed to drive a Worthington pump and a 40-light Westinghouse alternating-current arc-light dynamo, and as a direct-current generator it furnished current at 500 volts to two 30-horse-power street-railway motors, to a 60-horse-power motor driving an Ingersoll-Sargeant air-compressor, and to a series of constant potential arc-lamps.

Another circuit from the switchboard was connected to a 60-horse power two-phase motor and transformer, which, receiving alternating current at 360 volts, delivered a direct current at 50 volts, which was used in operating a large Shuckert search-light and which was suitable for electrolytic and other work. Still another circuit from the switchboard supplied current to a 60-horse-power two phase Tesla motor of the synchronous type directly connected to a 45-kilowatt constant-potential alternator employed for incandescent lighting, and another circuit furnished current without further transformation to incandescent lamps. All of the transformations and all of the uses indicated in the above-mentioned applications were at different times, and when not incompatible with one another, simultaneously exhibited, and, being in every case on a commercial scale, constituted the crowning triumph of the electrical display. It was an object-lesson which must have satisfied those who had questioned the flexibility of the electrical method of transmission of power and transformation of energy. It was a realization of the theory of the correlation of forces such as neither Mayer nor Joule could have dreamed of when they first announced it.

But perhaps the part which electricity played in the transportation problem at the World's Fair came more nearly home to the masses. Within the enclosure there were three principal means of conveyance, viz.: the electric launches on the lagoons, the Intramural electric railway, extending around something more than three sides of the grounds, and the movable sidewalk, extending along the steamboat pier from the Casino to the further end. Subsidiary means of transportation were furnished by the three large traveling cranes, of 20 tons capacity each, in Machinery Hall, which ran the whole length of the building, and which, after having done duty in installing the heavy machinery, were pressed into service to give visitors a bird's-eye view of the great mechanical exhibit, the numerous elevators in the several buildings, and the roller-chairs. All of these, except the last, were electrically propelled, and in the aggregate carried many millions of passengers.

The movable sidewalk was interesting as pointing a wide departure from established methods in transporting passengers. In this, a continuously moving carrying platform, supported upon and propelled by the periphery of the wheels of the trucks and therefore having double the speed of the latter, receives and discharges passengers while in motion by means of an intermediate slowly moving platform supported upon the axles of the trucks running upon an endless track. The relative speeds of the faster and slower platforms and the absolute speed of the latter are such as to render passage from one to the other, while motion is maintained, safe even for women and children. Since both platforms are continuous and run in closed paths, there is as much up hill as down hill and the path is therefore reduced to a plane. Since there is neither starting nor stopping, the element of the overcoming of inertia is likewise eliminated, and on theoretical grounds, at least, ideal economies should be maintained. Just what the economy was in this case can only be told when the final figures are published, but it will undoubtedly be large. In some careful experiments made by Frank J. Sprague some years ago on the Third-avenue Elevated railroad in New York, it was found that 83 per cent. of all the power utilized was consumed in overcoming gravity and the inertia of trains and that but 17 per cent. was required to maintain them in motion. It may be mentioned that the movable sidewalk was the most formidable competitor for the franchise which was finally granted to the Intramural railway, and that it has been seriously proposed as a solution of the congested transportation facilities in New York city, but it would appear to be of questionable availability for the latter purpose. The electric launches were a success financially, electrically, and popularly,—upon this all are agreed.*

Although the route pursued by the electric launches was almost an ideal one, bringing into direct communication with one another all the principal points of interest within the grounds, it was not used as a *convenience* by the masses, because of the exorbitant fares charged which made the use of the launches a luxury. In strong contrast with the launch route was that followed by the line of the Intramural railway. This led *from* nowhere *to* nowhere, and al-

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* Some figures presented in the Department of "Electricity" this month give an idea of the work performed by these launches and of the cost.—THE EDITOR.

though the charges were fairly reasonable, no one thought of patronizing its cars for convenience. The concessionaries, however, were not responsible for the bad location, as they were obliged to content themselves with what they could get. That it carried without serious hitch or accident nearly six million passengers during the term of the Fair speaks volumes for the success of the experiment.

The General Electric Company, who under the name of the Western Dummy Company were the successful competitors for the franchise, have in the Intramural railway apparently solved in a satisfactory manner one of the burning questions of the day, viz.: electrical traction for elevated lines and others having their own right of way. Whether or not all of the technical and financial details have been satisfactorily solved, no one but the General Electric Company yet knows, but the public were satisfied with the service which was maintained without interruption, and this must be counted a long step in its favor.

From one point of view, the Intramural railway experiment is the most important that has ever been tried in the practical application of electricity. It has demonstrated to the public the entire practicability (from their point of view) of the application of electricity in large units to the traction problem. It has furnished to its projectors the first authentic data upon which to base future estimates, and if mistakes have been made it will enable them to correct them in future installations. In brief the system employed was as follows: Trains were made up of three trail cars and a motor car upon which latter were placed four motors—one to each axle. The method of control was what is known as the "series parallel," by which the four motors, each of 133 horse-power capacity, are thrown at starting in series of four, followed by a parallel arrangement of two in series and finally of all four in parallel. By this arrangement the required maximum torque at starting is obtained with a minimum flow of current and a more uniform consumption is maintained at all speeds. The current is carried to the motors by means of two overrunning trolley shoes running upon a third or trolley rail to one side of the track and is returned to the generator by means of the track and the iron girders of the elevated structure. A fourth rail, extending about three-fifths of the length of the structure and connected at frequent intervals with the trolley rail, does service as a feeder. The actual length of the road is 14,800 feet of double track and 1900 feet of single track, and in this distance grades of from 0.42 per cent. to 2 per cent. are encountered and numerous curves down to 100 feet radius.

All of the cars are 50 feet in length and weigh, the trailers 20 tons and the motor cars 30 tons, when filled with passengers. Thus it will be seen that the conditions met with in the elevated roads of New York and elsewhere were in all points fairly duplicated. The maximum number of trains in service was fifteen, and these were run at a five minutes headway.

The Intramural power-plant, which comprised by far the largest part of the generating apparatus intended for power purposes at the Fair, did double duty. First it served as an exhibit for the General Electric Company of their largest sized railway and power generators and the various methods in vogue of hanging the armature and of driving it. There were in all five enormous generators shown—one 500 kilowatts four pole generator, driven by belt, and one 250 kilowatts, six pole, one 400 kilowatts, twelve pole, one 750 kilowatts, twelve pole, and one 1500 kilowatts, 12-pole generator—all directly connected to various makes of engines. The last is the largest dynamo thus far constructed, but so rapidly are large units growing in favor that there are already several others exceeding this in output either under way or contracted for. The capacity of this plant was of course far in excess of the demands made upon it by the Intramural railway, so that the various generators took turn either singly or in multiple in supplying these wants.

The enormous outlay required for this magnificent exhibit precludes the possibility of its having made in dollars and cents an adequate return to the exhibitors. They evidently relied for reimbursement upon the experience and prestige it would give them in this hitherto practically untouched field of electric traction, and the renewed consideration which electricity is receiving in our larger centers of population on urban elevated and interurban routes gives promise that their confidence was not misplaced. For obvious reasons the General Electric Company have declined to make public the technical results of the experiment, but however much this may be regretted from a professional point of view, there are few who in their hearts will blame them.

WHAT CHEMISTRY OWES TO ENGINEERING.

By Joseph Torrey.

MOST of the so-called sciences have had their origin among schools and thinkers, pure and simple. As one traces their history he will find that they long remained, as at first, the property of the few ; their influence was an intellectual rather than a commercial one, and their apparatus crude and imperfect. In the course of time, however, these retiring servants of mankind have been, one by one, drawn forth from their seclusion and enlisted in the great army which turns nature's resources into money. The history of chemistry is a somewhat peculiar one in this respect, for it has been longer in the field than any of the other sciences. In fact, its results were made use of long before we have any authentic record of its development as a pure science ; this fact, however, is true in several other cases. For example, the manufacture of iron extends back beyond all *historical* record. The reduction of iron from its ores is a purely chemical process, though not an easy one to carry out in such a way as to obtain a useful product. The same is true, and more emphatically, of its conversion into steel. By what gropings and chance observations the bare facts necessary were discovered we can only surmise. At all events it seems to be quite evident that the credit for whatever success attended these early efforts, must be laid to engineering rather than to chemistry, for men were of necessity engineers before they were chemists. Instances such as this might be multiplied, but I doubt if the point would be any clearer than this one notable instance makes it.

In order to appreciate the relationship between engineering and chemistry it is necessary first to premise a few facts that are probably unfamiliar to those who are not chemists, but which must be understood fully in order to enable us to rightly apportion credit in any given case. Let us come back to iron-manufacture. In these days it is an easy matter for the chemist in his laboratory to take a small quantity—say 100 grains—of iron-ore and obtain from it practically all the iron it contains in a nearly

NOTE.—This article was suggested by a similar one, by Mr. Griswold, on "What Engineering Owes to Chemistry," which appeared in THE ENGINEERING MAGAZINE of November, 1892.—J. T.

pure state. In precisely the same way any one of the chemical manufacturing processes in use to-day—for example, the aniline, soda ash, or sulphuric-acid manufactures—can be carried on in chemical laboratories on the small scale, with better results than in the manufactories themselves ; but every chemist of experience knows that it takes only a very slight increase in the scale of operations to make a vast difference in the product and the "yield" of that product, and even though the capacity of the apparatus be increased so as to make it possible to handle large amounts, say a pound or so, of material, it is invariably the case that only part of the difficulty is thus compassed. Small reactions and disturbing effects, not noticed on the small scale at all, suddenly rise up and demand attention. If heating is demanded, it may appear that uniformity and regularity of heating is more important than was first supposed. The unavoidable loss of material increases, and on all sides it appears that the whole matter must have a new thinking over.

Now when this second thinking over comes in order, it often appears that chemistry has done about all it can and that recourse must be had to what is really engineering, and not chemistry. If there is loss in transferring material, then some device must be thought out by which this transference can either be made more economically or avoided altogether. If the trouble is that materials do not get thoroughly mixed or that heating is not uniform throughout the mass, we must find some way of keeping our materials in agitation by some kind of a mechanical stress ; or if it is a furnace process we are dealing with, it will be necessary to devise some way of charging the materials so as to secure uniformity of distribution. These and other similar problems having been solved, material can be handled in the laboratory on a moderate scale, provided the question of dollars and cents is not too prominent.

Let us take one step more, and come up to commercial application of our process, whatever it be. We are now concerned, not with grains of material, but with tons ; and the sole question now is not "Can this product be produced ?" but "Can it be produced profitably ?" Let us see what this latter question means. It means that the plant must produce material the sale of which will cover the cost of production and pay dividends on the capital invested, besides insurance, taxes, etc. In order that this may be the case the apparatus must be planned so as to be as durable, simple, and easy to repair as possible ; and if any part of it is particularly exposed to rapid deterioration, arrangements must be made by which it can be readily removed and replaced by a new or newly repaired piece. The cost of production involves among other things the cost of moving material from one part of the plant to another. This cost must be a minimum. In almost every such process, moreover, fuel is used in large quantities, partly for heating materials, perhaps, and also for steam power. Most of the work done around the establishment must necessarily be of the nature of plain, unskilled labor, and acordingly things must be so planned and arranged that such labor will answer.

On the other hand, some problems arise,—sometimes the most serious ones in the whole collection,—which are chiefly chemical. For example, suppose we find it necessary to keep in agitation a large mass of material which happens to be such as to corrode iron rapidly. It is necessary to construct our vat of some other material, and the search for such material is often long and discouraging. Perhaps we find it necessary to keep our material at a dazzling white heat in lots of ten tons at a time in a furnace. We shall have many long and stern battles with that problem before it is solved. Here it is not only a question of chemistry. It involves full as much engineering. From this survey of the case it is evident, I think, that the minute we attempt to take any process, no matter how simple, out of the laboratory and make a commercial process of it, it becomes an engineering problem, and its successful consummation requires the exercise of the *engineering sense* rather than the *chemical sense*. From this point of view, if the question be asked 'What does chemistry owe to engineering?" it may be replied that in so far as chemistry has been successfully applied in the arts the credit belongs chiefly to engineering.

I shall confine myself to two cases which illustrate this. There are many others, but in order to see fully the point in each case it would be necessary to go into details more than space will permit.

Let us first consider, then, the manufacture of pig iron in the blast-furnace. The problem is to obtain metallic iron from some available iron "ore," that is, from some naturally occurring iron compound which is abundant enough and rich enough in iron to be worked on a commercial scale with profit. The chemical fact with which we start is that the principal ores of iron available are reduced to metallic iron by heating in contact with some form of carbon, such as charcoal, coke, or coal. In practice, even on a relatively small scale, it is found necessary to add limestone to the charge, because it has the power of forming a fusible *slag* with the impurities contained in the ore and fuel.

Such is the bare outline of this great manufacture. It is simplicity itself, and yet the development of its resources as a manufacturing process has been one of the great achievements of recent years. The reduction of the ore to metallic iron is carried out in so called blast-furnaces. These are of colossal dimensions, being often over eighty feet high and twenty feet in diameter at the widest part, and sometimes having an output of over two hundred tons of pig-iron in twenty-four hours. The proper consideration of the blast-furnace itself would take volumes. To point out even superficially the nicety of engineering involved in its construction, and the " ways that are dark and tricks that are vain " of which it is capable when in operation, would be an almost endless task. We will adhere to the original plan and only point out how it has developed from crude beginnings to its present state. To begin with, it became evident that the process of making iron in the furnace must be continuous. That is, it would not pay to fill up the furnace with ore, fuel, and limestone, melt down that charge, draw off the iron, and then fill up again. In the first place, it would prove wasteful of fuel. In the second place, it would, owing to the frequent heating and cooling, be very trying to the furnace-walls, causing cracks and distortions, and, taken all in all, the cost of producing metal in large quantities would be too great. The problems presented here are purely engineering ones. Again, it was found necessary to supply forced draught ; and the history of the various contrivances that have been employed as blowing engines would form material for another large volume.

All this time the top of the furnace had been open and all the waste gases allowed to burn there. Soon it was seen that these gases might be carried off and burned, and the heat utilized. The first use that was made of the heat thus saved was in heating up the air which was to be blown into the furnace by the blowing engines. Then the general shape and arrangement of things around the furnace underwent a change. Instead of being built of fire-brick, the "stack" was sheathed with boiler-plate, making a neater and more compact structure. The means of getting materials to the top for charging were improved, and ingenious methods were devised for charging the ore, fuel, etc., into the furnace without waste of time or gas.

In all these cases engineering has been the important factor.

Meanwhile chemistry has been at work in other ways. Without careful analyses of ore, fuel, limestone, and the finished product, the pig-iron as well as the slag, it is extremely difficult to properly proportion charges so as to get a uniform product and good economy of production ; and of late years the chemical laboratory is a fixture in every well appointed blast furnace plant. With this hasty survey let us pass on to look for a moment at another chemical process which has been commercialized on fully as heroic a scale as the one just considered, and which is the greatest existing instance of the dependence of chemistry upon engineering in its commercial application. I allude to the Bessemer process for making steel.

The principle is extremely simple. Steel contains less carbon than cast iron and also contains some manganese. Now the Bessemer process starts with cast-iron, and first removes all carbon from it ; then adds the right amount, and the necessary amount of manganese. The product is steel. Melted cast-iron (perhaps ten tons) is poured into a huge egg-shaped vessel which hangs on trunnions with its large end down and is called a *converter*. The bottom of the converter is so arranged that air can be forced in through small holes and made to bubble up through the melted iron. The oxygen of the air then seizes on the carbon in the iron and burns it just as the coal is burnt in a stove, only more furiously. The time taken to burn out the carbon varies—according to the amount of iron *blown* and the quality of the iron—from 7 or 8 to 15 minutes. During the process flame shoots out of the opening at the top of the converter, short and dull at first, but long and brilliant toward the last. When all the carbon is gone the flame suddenly *drops*, *i. e.*, shortens and grows dull. The converter is now turned on its trunnions till its mouth comes down, so that there can be poured in a certain amount of an iron which contains the required amounts of carbon and manganese. After standing a few minutes the charge of fluid steel is poured out into a great ladle handled by a crane, from which it is run into ingots which are usually carried off to another part of the works, reheated somewhat, and rolled into rails.

Simple as all this may seem, it required years of unsuccessful and discouraging work to bring it to a point where it was commercially successful. Chemistry has done its part. Only by careful analysis of materials and product has it been possible to follow clews which led to the production of a marketable product ; but on the other hand, the engineering problems presented have been simply stupendous and have in their solution drawn out the greatest mechanical engineering of the present century. Any one who reads, as every young engineer should again and again, the life of Alexander L. Holley, will find most of it there.

In the first place, the process must be continuous. This involves first of all the question of a suitable converter lining. The temperature which it has to stand is enormously high, and this, combined with the washing of the melted metal and slag against the sides, demands an extremly durable and manageable material. The bottom linings in the early days gave out very rapidly and the process of cooling down and repairing this lining was a tedious and wasteful one. Holley solved this problem in his usual brilliant fashion by making the converter bottoms removable and planning so that, while one bottom was in service, another should be in process of repair. The change only occupies a few minutes, and as the new boiler is thoroughly dried and heated by a gas flame before being put on, there is practically no trouble from *chilling*.

But after all the greatest problems came up in connection with the general arrangement of the whole plant in such a way that materials could be handled with the greatest ease and expedition. The complete manner in which they have been met and solved is best appreciated by a visit to some large modern Bessemer works such as that of the Bethlehem (Pa.) Iron Company, or the Illinois Steel Company's South Chicago plant. In such an establishment there is hardly a single piece of machinery from converter to ingot mold which is out of employment more than a few minutes at a time. From the time the iron enters the top of the blast furnace as ore, till it emerges at the end of the " finishing train " as a rail, it is in almost continuous motion.

It goes without saying that many others of the great modern industries which are essentially chemical in principle would, on study, show the same fact as the two we have considered. It seems to me that the most important conclusion to be drawn is that young men who are studying chemistry with a view to entering on industrial work had better take occasion to acquire some engineering knowledge. One of the best ways to do this is to see as much good engineering work as possible, and not only see it, but *think about it*. The great defect in our modern schools is that students have so little opportunity to meditate.

AMERICAN AND FOREIGN PATENT SYSTEMS.

By Casper L. Redfield.

IN the early history of nations, despotic monarchs were wont to grant monopolies and exclusive privileges, known as patents, to certain individuals. These grants were not made out of any sense of justice and right, but simply as royal favors to certain court favorites. The first English parliament under James I. limited the grant of such exclusive privileges to cases of invention, and thus laid the foundation for the patent laws that are now in force in various countries.

The patent laws of the United States have their origin in the constitution, which gives to Congress the power to promote the progress of science and the useful arts, by securing to inventors for limited times the exclusive right to their respective inventions. Acting under this power Congress enacted the first patent law on April 10, 1790, since which various other laws have been enacted, the most notable and comprehensive of which are the laws of 1836 and 1870. The regulations under which United States patents are obtained and controlled may be classified under three heads :

First, laws enacted by Congress.

Second, interpretations put upon these laws by the courts,—or "court made laws" as they are sometimes called.

Third, rules made by the Patent Office.

While these laws, rules, and regulations are for the most part liberal to the inventor, and better than those of any other country, still there are many points where improvements could be made, the results of which would be increased liberality to the inventor and increased benefit to the general public.

The spirit and intent of all patent law should be to secure, for a limited period, to the actual inventor the thing that he actually invents, to the end that individuals may be induced to make new improvements that shall ultimately become public property. As the making and perfecting of inventions is a costly and somewhat hazardous undertaking, that law is best which properly protects an invention at the least cost and trouble to the inventor. Under the laws of most, if not all, foreign countries, a patent is simply a government certificate to the effect that a certain individual claims to have invented certain new and useful improvements, properly described, and that he has the right to use the machinery of the law to prevent others from making and using his actual improvements. In the United States this certificate is the same, except that it has the added force of having been passed upon by certain government officials, called "examiners," who have carefully scrutinized the application and have found no reason why the inventor is not entitled to that which he claims. As the courts will not protect an inventor in the use of things which were not first original with him, and as the multiplicity of improvements makes it impossible for one person to know all that has been done, it will be seen that the judgment passed by an individual who has exceptional opportunities for finding out what has been done in any particular art is of material advantage, not only to the public, by preventing it from being imposed upon by spurious patents, but also to the inventor, by preventing him from wasting time, money, and energy on old things under the belief that they are novel.

The United States supreme court has said: "A patentee has two rights, first, to make, use and sell his invention, and second, to prevent others from making, using or selling it." Also, "as patents are procured *ex parte*, the public is not bound by them, but the patentees are."

From these decisions of the court, and from the preceding remarks, it is evident that the actual inventor may invoke the law to protect him in the exclusive use of the thing that he actually invents. Before he can do this, however, he must have a patent that properly sets forth his invention, because the courts will not take cognizance of what his real invention is, but of what his patent says the invention is. Furthermore, the statement of what the invention is, is not to be found in the drawings, nor in the description that occupies the bulk of the space in patent papers, but in claims that are appended to the specification, and to the statement made in these claims the patentee will be strictly held.

It is therefore of the utmost importance to the inventor that the person who writes these claims should fully understand what is the spirit and essence of the invention, and be able to state it in clear and unmistakable language. How illy this is now done is shown by the fact that probably in not more than one case in ten, and possibly in not more than one in fifty, do the claims of a patent set forth clearly and succinctly the whole of the real invention. This failure to express the invention clearly and completely is due to (1) the lack of knowledge of the exact state of the art, (2) the failure of the attorney to fully comprehend the scope of the invention, or (3) the inability of the inventor to properly explain his ideas.

Not only is an imperfect patent detrimental to the interests of the inventor, but it is also detrimental to the interests of the public. Every patent that is issued and fails from any cause whatever to be of a benefit to the patentee, discourages some other inventor; and every patent that is successful for a time only to be ultimately declared void or nonoperative by the courts, discourages capital from assisting other and meritorious inventions. Many valuable improvements are, from these causes, lost to the world until other inventors reproduce them, perhaps only to be lost again in the same way.

Improvements in the laws relating to patents should be along such lines as will best remedy these defects, to the end that, when a patent is once issued by the government, the owner may have something tangible and real,—something about which there is a reasonable degree of certainty that he can protect and maintain it. There is one class of individuals who would carry this to the extreme of having the government guarantee absolutely the validity of every patent issued, while there is another class who would have the government, on application, issue a patent to anybody for any thing without any questions whatever. In neither of these propositions can I concur. In the first case, absolute guarantee would negative the fundamental principle that exclusive rights are to be granted only to the first and original inventor, for the reason that, while there may be a moral certainty that the invention was never before known and used, there always remains the chance that it ultimately may be shown that some one else has a prior claim. The world of inventors is altogether too large to make absolute guarantee a possibility.

The second manner of issuing patents is that adopted by countries other than the United States, and which marks the chief difference between the American and foreign patent systems. If we should follow this free and easy method of issuing patents, a patent would have no more force and value than the unsupported statement of any unknown person. Such patents would have to win the support of capital by smooth and seductive talk rather than by merit,—a condition of things that would put the honest inventor of a valuable improvement at an immense disadvantage. On the other hand, if a patent represents an actual improvement, and if there is a moral certainty, amounting almost to an absolute one, that the owner of the patent is also owner of the improvement it represents, then the inventor, no matter how humble his position in life, can go with confidence to the capitalist, and the capitalist will receive him respectfully, well knowing that he represents some thing of value, and perhaps of great value.

To bring about results that will tend to eliminate worthless patents and also to enhance the face value of those issued in the future, we must attack individually the defects as they exist in the law. In the first place, it is desirable that patents be not issued for devices that are old, and that matters to which the inventor is not obviously entitled should be rigorously excluded from the claims. This cannot be done unless the state of the art to which the invention pertains is fully and accurately known. To this end I would recommend that the Patent Office be supplied with additional data, including books, periodicals, catalogues, circulars, and all other publications relating to the various classifications of inventions, and that the force of examiners be increased sufficiently to enable them to refer to these as well as to the patents of record. Also, that the examiners, in addition to citing references that bear directly upon the claims submitted, be required to cite other patents or publications that show an advanced or special state of the art. As these things are certain to come up at some time during the life of a successful patent, it is the part of wisdom that cognizance be taken of them at the outset, so that time, money, and labor may not be uselessly expended. As the inventors pay all the expenses of the Patent Office, the additional force here recommended could not reasonably be objected to, especially as the results attained would be fully as advantageous to the public as to the inventors themselves.

In the second place, attorneys who are admitted to practice before the Patent Office should be only such as are competent to clearly understand an invention and to set it forth in concise language. At the present time, in the United States, any one is at liberty to act as an attorney in patent applications, and many cases are prepared by persons totally unfit for the service. This is often the case when patents are obtained on what is known as the "bureau system." In offices where this is practiced, applications are prepared by a force of clerks whose only object is to obtain an allowance and issue of the patent without respect to the nature of the claims that go to make up the patent. Such practices should be abolished, and no one should be permitted to act as a patent solicitor who has not demonstrated, by passing a satisfactory examination, that he is competent to understand and properly explain the mechanical principles that go to make up inventions. To still further insure that each patent issued be prepared in the best possible manner, each examiner in the Patent Office should be instructed to suggest certain claims, whenever it became obvious to him that the inventor or his attorney was overlooking some important matters that should be incorporated.

With these two improvements carried out in a proper manner, patents would rise considerably in character and commercial value, capital would be less shy in embarking upon enterprises based on patented improvements, and many valuable inventions would be saved from an untimely death.

It does not follow that all the improvements in the patent laws should be in the line of increased liberality to the inventor. Some should be made in the interest of the general public. One need may be pointed out particularly that relates to the duration of the patent and the time occupied between filing and issuing. The majority of inventors are anxious to have a patent issued as quickly as possible. Old hands at the business, and especially corporations, often take an exactly opposite course, and delay issue as long as possible. These delays are deliberately brought about, sometimes for the purpose of secrecy, sometimes to give time for the preparation of other cases, and sometimes for the purpose of prolonging the life of the invention. The first two reasons for delay are legitimate, but the last is not, hence it is an abuse of a privilege for the sake of private gain. To show to what extent this abuse has sometimes been carried, it is only necessary to state that in one case an application was kept pending for fourteen years, thus giving the owners a practical monopoly for thirty-one years, or nearly double the time contemplated by law. How long a patent might be kept pending in the Patent Office by skilful or unscrupulous attorneys, is a matter of doubt. Possibly the larger part of a century might be consumed by dilatory tactics if there was any object in it, and no new law intervened.

To do away with this abuse, some writers have advocated dating patents on the day of filing and not the day of issue, as is the case in foreign countries. To this change I am opposed, because under our present system, or any system that I would advocate, the inventor has certain legal and equitable rights that would become forfeited if a patent took the date of filing, and because the abuse can be corrected by simply removing the incentive, without at all curtailing the rights and privileges now enjoyed. As the sole object of extending the time that elapses between the date of filing and the date of issue, beyond what is necessary to protect the interests of the inventor, is that of maintaining a longer control of the invention, the remedy is a proviso in the law that, while a patent should have a life of seventeen years from the date of issue, no patent should extend to more than a certain number of years beyond the date of filing. This term I would set at twenty years, thus giving the inventor three years in which to prepare his application for issue without having time run against the life of the patent. The three years provided in which to prepare the application for issue is ample time for the great majority of cases. Where more time is consumed for any reason it should run against the life of the patent. I believe the corrective will fully remove the abuse.

In most other countries annual taxes must be paid on each patent, and there are requirements compelling the manufacture or use of the invention within prescribed limits of time. Onerous exactions of this kind tend only to discourage and restrict invention, and should have no part in the laws of the country where the constitution gives Congress the power to "promote the progress of science and useful arts." It is true that a practice has grown up of buying-in competing patents and pigeon-holing them to remove competition. Requirements as to taxes and workings would find their only justification in attacks upon such cases, but as this practice is indulged in only by wealthy corporations, the remedy would fail of its effect, while many poor but worthy inventors would be wiped out of existence.

Patent law is a thing somewhat apart from ordinary law. This is due largely to the fact that to be a successful patent lawyer or solicitor requires a knowledge of mechanics. It follows, therefore, that patent attorneys are specialists, that the court which sits in judgment upon patents should be composed of specialists, and that the Congress which makes the laws relating to patents should have the advice and assistance of specialists.

Under a patent law that is to-day more liberal and beneficent than that of any other country, more inventions have been made in the United States than have been made by any other people, and we have established more manufactories based upon inventions than can be found in any other land. Under a law still more wise in its provisions, inventions will increase in number and in value, foreign countries will pay us tribute for their use, manufactories will multiply, and general prosperity will abound. Casting my vision into the distant future, I can see a time when the very existence of the human race may depend upon some invention not yet made and not now dreamed of. It is therefore not well for us to harass and discourage the inventor by petty exactions of the law, but rather should the strong arm of the law reach forth to lift up, support, and encourage the inventor in his good work, that we and our posterity may be benefited thereby.

ELECTRICITY

Conducted by Franklin L. Pope.

THE Intramural railway may fairly be considered to have been one of the principal electrical successes of the World's Columbian Exposition. No less than 6,000,000 passengers were transported during the continuance of the fair, and not a single casualty of any kind occurred. On "Chicago day" the number of passengers reached its maximum of 125,000. It is said that the results of operation, which at the time of this writing have not been made public, will conclusively demonstrate the economy as well as the convenience of this method of operating rapid-transit lines. It is not likely that the change from steam to electricity will be made at present on any of the existing elevated lines in our large cities, inasmuch as it yet remains to be proved that the saving in cost of operation would be sufficient to justify the enormous expense of the necessary alterations, while on the other hand it is certain that no material increase could be effected in the carrying capacity of the trains. But in all the new lines about to be established, the question whether they shall be equipped with steam or with electricity is a most important one, and one not to be decided except after the most serious consideration. The full returns of the operations of the Intramural railway, when published, ought to throw a great deal of much needed light on this troublesome problem.

THE Liverpool overhead electric railway is equipped with an ingenious system of automatic electric signals, which, as far as we are aware, are the first which have been operated in Great Britain with wholly satisfactory results. A section of one of the British main lines is now to be equipped with electrically operated signals, switches, and crossings, controlled by small hand-levers in the signal cabins. The actual movement of the signal-arms and switches in the system is to be effected by the direct action of large long-range electromagnets energized by a strong dynamo current.

A LARGE contract for electrical machinery for the Niagara plant has been awarded to the Westinghouse Company, of Pittsburgh. The system which has been adopted is known as the Tesla polyphase. The present contract calls for three 5000-horse-power generators, with a corresponding equipment of motors, switches, etc. The rotating fields are carried on the upper ends of vertical shafts, and are thus coupled direct to the turbines. The upward pressure of the water supports the entire weight of the turbines, shafts, and rotating parts of the generators, thus doing away with nearly all the step-friction. The electromotive force of the dynamos will be from 2000 to 2400 volts, which will be raised and lowered by transformers at different points as required. The system adopted would seem to provide for every possible requirement of an electric service, either in the way of illumination or power.

IT is becoming very evident that some additional safeguards are necessary in the electric street-car service. Not to go back more than three months, there have been two runaways of electric cars on steep grades, in which over forty passengers have been more or less injured; five of them fatally. Four or five collisions of cars have occurred, in which nearly twenty persons have been injured, and at least three killed. Two or three instances have also occurred of street-cars having been struck by locomotives at grade-crossings. Any one who will take the trouble to follow the monthly reports of railroad accidents, as published for instance in the *Railroad Gazette*, will soon be convinced that the reckless construction of electric lines across steam lines at grade, has introduced a new and very serious danger to the traveling public. President Clark of the New York, New Haven and Hartford railroad, in his annual report for the current year, says that "if the public exigency requires those roads to cross steam-roads, it should first compel a separation of grades under the operation of law." The *Railroad Gazette* pertinently observes that the electric railroads will generally be built in sections of the country which have already reached such a development as to justify restrictions upon crossings at grade, and that now, at the inception of what is bound to become a vast system of electric cable railroads, is the proper time to institute proper public control of crossings. The *Gazette* points out that the danger of collision at grade-crossings is greatly enhanced by the circumstance that the number of trains on the electric road, for a given number of passengers, is necessarily much greater than on the steam road.

THE *Electrical World* directs timely attention to a fact very familiar to engineers, that of all branches of engineering, there is scarcely one which calls for the exercise of more common-sense and good judgment, or in which the services of a competent engineer for the preliminary studies is more vitally necessary, than that of designing a combined water-power and electric transmission plant, There is a popular impression that water-power does not cost anything, but this is decidedly not the case. The matter certainly should not be left, as it often is, to the judgment of the selling agent of an electrical manufacturing concern, whose eagerness to effect a sale of the necessary machinary, and to pocket the commission thereunto appertaining, is liable, perhaps, to bias his opinions.

THE London, Brighton and South Coast railway of England has thirty of its trains lighted by electricity, and is now about to equip a number of additional trains. It is said that about 15 per cent. more work can be got out of an electrically-lighted than of a gas-lighted train, which makes a saving in first cost of about $225,000, as 85 electrically-lighted trains can do the work of 100 gas-lighted trains.

IT is stated that the trustees of the Brooklyn bridge are considering the feasibility of substituting electricity for steam in the propulsion of the cars. It is probable that the terminal switching, at least, might be performed advantageously in this manner.

A FEW years ago the process of electric tanning, which is now being extensively used in Europe, was presented to some of the leading tannery proprietors in this country, and was condemned by them on the ground that, even if the process possessed all the advantages claimed for it in the way of expediting the production without injury to the product, there would be no money in it. Now it is announced that the largest tannery in Switzerland is to be reconstructed and enlarged by means of an electric process.

THE plan of increasing the transmitting power of a magneto-telephone by making use of a plurality of diaphragms coupled to a plurality of generating devices, has been invented and reinvented a great many times within the past fifteen years, but practical tests had invariably demonstrated that one diaphragm was as good as a dozen, for all practical purposes. Recently, an inventor with a little better head than most of the others, bethought himself that the trouble might possibly be that the several diaphragms not only did not vibrate in exact unison, but that they more or less worked against each other. So he coupled several diaphragms together by means of a simple mechanical contrivance, with results that are certainly quite surprising. The volume of sound appears to be increased many fold, and when used as a receiver for the standard telephone transmitter, can be heard and understood several feet away. For private lines, this would appear to be a most admirable instrument, if the mechanical attachments do not give trouble, which indeed there is no particular reason to expect.

An electrically-operated typewriter has been for some time in use in Boston, which is so arranged that it may not only be used in the ordinary manner for office correspondence and copying, but may be electrically connected with a similar instrument at a distance, so that a copy of the work may be automatically reproduced thereon, even in the absence of an attendant. Such a machine apparently possesses great possibilities of future usefulness.

Professor George Forbes, at the International Electrical Congress, said that one of the most important points now to be considered by electrical engineers is the commutation of the alternating into the direct current. He remarked that every advocate of the continuous current,—and it has had, he thought, some very bigoted advocates,—would have been convinced in favor of the alternating current dynamo, if he could have been assured that a commutator could be placed at the far end of the line instead of at the power station.

It is stated that there are now in the United States more than 300 mining companies making use in their operations of electricity for light and power. About one-third of the gross amount of copper refined in this country is now treated by electrolytic processes.

The news of the victory of the *Vigilant* in the international yacht race was received in Glasgow within 30 seconds after she crossed the finish line in New York harbor. The Commercial Cable Company transmitted the despatch.

In a recent number of this Magazine reference was made in this Department to a conduit system of electrical distribution for street-railway service which was being experimented with at Coney Island, with very promising results. It is well known that the principal difficulty in a system of this kind is that of preserving an effective insulation. A series of careful measurements executed by a well-known electrician on a section of 75 feet in length of the Coney Island conduit, which had been completely filled with water, showed a loss of current equal to only 1 horse-power for five miles. A similar experiment made with the car connections submerged, showed that the loss was approximately equal to one-thirteenth of the power required to propel the car. These conditions are apparently much more unfavorable than any which would be likely to arise in practical work. A system that can show such results as this is certainly worthy of a trial under actual conditions of service. If it is practicable to banish the overhead wires from the streets of large cities like Boston and Brooklyn, it ought to be done. But whether it is practicable or not, is one of the things which yet remain to be demonstrated.

One of the most recent electrical power-transmission plants in Switzerland presents features of novelty and interest. An average of 350 horse-power is transmitted a distance of about eighteen miles and is employed to operate a paper-mill. Two direct-current dynamos are connected in series, giving a current of 43 amperes at an aggregate potential of 6000 volts. The line wires are of copper 0.28 inch in diameter, and are strung overhead on porcelain insulators, affixed to poles thirty feet in height.

An admirable example of the variance which is occasionally found to exist between law and common-sense, is that of a recent decision of the corporation counsel of the city of New York, in which he held that the Broadway cable railroad cannot be permitted to lay a wire in its own conduit for the purpose of signalling to the power-house to stop the cable in the event of an accident on the line, because the subway company has been invested with the exclusive right to lay wires in the streets of the city. The ultimate result of this prohibition will probably be a serious disaster, in which a car will run amuck the whole length of Broadway, carrying devastation in its path.

A complete system of toll telephone lines is now under construction by the British post-office, intended to reach every town in the kingdom of any commercial importance. A central toll-line exchange is to be established at Leeds, where the switching will be done.

A system of electrically-controlled clocks has been arranged in Berlin, in connection with the electric-light and -power service. Once each day, at an hour when few lamps are in use, a momentary diminution of pressure in the mains, of about 10 volts, winds and sets the clocks, which are disconnected from the circuit the rest of the time.

The reports of the working of the City and South London electric railway are very satisfactory. It appears that, while both the mileage and traffic have considerably increased over last year, the operating expenses are actually less. The cost of power generation and locomotives, which was at first 18 cents per train-mile, and 15.4 cents last year, has now been brought down to less than 13 cents.

It was remarked in this Department last month that it was to be regretted that the electrical exhibitors at the World's Fair had in so many instances neglected to place some person in charge who was capable of giving an intelligible account of their exhibit. But it seems that they have in some instances been guilty of even greater folly. If any of them have failed to receive the award to which the merits of their exhibit entitled them, it is suggested that they ask themselves if the person selected to present the merits of the article to the judges was nothing more than a glib-tongued salesman, who although entirely competent to talk the tribunal deaf, dumb, and blind, was utterly incapable of giving an intelligible reply to the simplest question of a technical character. It is not easy to compute the aggregate amount of damage which has been inflicted upon the electrical interests of this country by apostles of this type, whose zeal (for a commission) is in most cases wholly untempered by discretion.

At the Milwaukee railway convention of the American Street Association, an interesting paper on the heating and lighting of street-cars was read by G. F. Greenwood. Mr. Greenwood, speaking of the problem of heating by electricity, said that the cost of installing four heaters in a car, with regulating switches and appliances, ranged from $35 to $45, and that the expense for electricity varied from 32 cents per car per day, in moderately cold, to 81 cents in severely cold weather. He estimated depreciation and repairs at 5 cents per car per day. Estimating that a car requires to be lighted an average of eight hours per day, the cost of the five incandescent lights usually required footed up at 4 cents per car per day.

A note appeared in the October number of this Magazine, criticising the primitive character of the arrangements for telephone service in connection with the new cable recently laid between Ireland and Scotland by the British post-office. We are glad to be authoritatively informed that our strictures were based on a misapprehension of the facts, and that the cable is designed to form part of a comprehensive scheme of intercommunication, in which ample provision is to be made for direct conversation between any two subscribers in any part of the United Kingdom.

Reference was recently made in these notes to a newly-discovered process of electro-deposition, in which the application of the plating mixture by means of a brush, as in painting, was thought to render it peculiarly well adapted to the plating of the bottom of iron ships with copper. It is now announced that a plan has been devised by which the ordinary process of electro-plating may be applied to the same purpose. A flexible bath is employed, which is secured to the skin of the vessel by magnetic or other means, so as to bring the solution in direct contact with a portion of the surface, the bath itself constituting the positive electrode, and the metal of the ship the negative. It has been found that a current of between 7 and 8 amperes per square foot at a potential of 1.5 volts, suffices to deposit a perfectly uniform, smooth, and adherent coating of copper to the surface of the vessel. A single deposit of sufficient thickness may be formed in about 72 hours. Of course, by employing a sufficiently large battery of dynamos, the plating process may be carried on simultaneously at any required number of places upon the ship. The quantity of copper required to coat the bottom of a ship 400 feet long and drawing 20 feet of water, is estimated at about 55,000 lbs.

AN insulated wire has been invented by an old and experienced electrician in the employ of the transatlantic cable companies, which appears to combine the impermeability and moisture-resisting qualities of the gums with the cheapness and convenience of the fibers which have hitherto been so largely employed for this purpose. It only awaits the invention of a really good insulated wire of this character, to bring about one of the most important reforms now needed in the telegraphic service,—that of the establishment of a sufficient number of underground trunk lines between our principal commercial cities. But for the necessarily high cost of wires covered with india-rubber and gutta-percha, and the inherent weak points of the fiber-covered wires, with which latter electricians are but too familiar, it is probable that something of the kind would have been undertaken before this time. We are always gratified whenever any advance is made in the art which promises to aid in bringing about this most desirable consummation.

THE application of the storage-battery to the propulsion of street-railway cars is being again tested on a large scale, this time on the Second-avenue line in New York city, and under conditions which seem likely to determine, for the present at least, whether the system is or is not a commercially practicable one. The work is being carried on in the most thorough and systematic manner, under the supervision of skilful and experienced electrical engineers, and great pains are being taken to determine what is in fact the vital point of the whole problem, viz., the actual cost of operation. The question is no longer merely one of practicability, for it is admitted that on lines with moderate grades, not too much obstructed with snow in winter, storage-battery traction may be depended upon to perform the service required. Thus far the figures of the Second-avenue line, with only six cars in operation, show that the cost of power, including everything properly belonging under that head, is 9.32 cents per car-mile. Horse traction is usually reckoned at from 10 to 11 cents per car-mile.

CONSIDERABLE surprise has been expressed at the statement, made at the International Electrical Congress at Chicago in August by a prominent California engineer, that in his state the transmission of power by electricity, up to date, had practically been a failure,—a surprise which has not been lessened by the fact that no one seems disposed to controvert the assertion. In a letter to the *Electrical Engineer* the author of the statement explains that the electric company which obtained an important contract sent out a thoroughly capable man to secure it, but unwisely entrusted to an incapable subordinate the work of actually superintending the installation. The power-house of the plant in question, it seems, is in a situation which is inaccessible during nearly half the year, and after a few days of not too successful operation, the field-coils of the generator were burned out, and other accidents which might have easily been avoided were permitted to occur, with the result of probably postponing the successful operation of the plant for a year. The writer adds that investigation has shown that there was no inherent defect in the system employed, and that the failure was directly attributable to a lack of careful and intelligent supervision during the erection of the plant.

THE new North End railway station in

Boston is to be provided with an electrical plant of 1100 horse power capacity. There will be some 4000 incandescent lights and 300 arcs, besides which the drawbridges, turntables, elevators, coal-handling machinery, etc., will all be operated by electric motors. It is expected that the work will be completed before winter.

THE record of the work of the electrically-propelled launches at the World's Fair shows that from April 13 to October 1, 1893, the 54 boats in service made 56,207 trips, and ran 168,621 miles, the average daily run of each being 25.57 miles. A total of 801,000 passengers were carried between May 1 and October 1. The average cost of electricity per launch per day at 3 cents per electric horse power, was 55.5 cents, and the total cost for electricity, repairs, renewals, inspection, and labor, exclusive of office expenses, was $1.48 per launch per day or 5⅞ cents per mile run. For a novel enterprise, carried out under many unfavorable conditions, it must be said that this is a most creditable showing.

A WRITER in the *Electrical Engineer* makes some sensible and pertinent observations in relation to the numerous accidents from electric street-railway cars which are almost daily reported in the newspapers. The blame of these casualties is invariably laid to electricity, and specifically to what the reporters stigmatize as the "deadly trolley," but as a matter of fact, neither electricity nor the trolley have anything to do with the actual source of the trouble. An analysis of the causes of accidents shows that the real difficulty in nine cases out of ten is lack of brake-power. "Electricity"—says this writer—"is the greatest force in nature, and is moreover, the most subordinate to control. Why then have we not, in an electrically propelled car, the safe and effective power to arrest its momentum and avoid accidents? The answer is, imperfect application." In conclusion, he suggests that the present evil is directly chargeable to the disposition of the manufacturers of electrical machinery to "let well enough alone." The criticisms of the newspapers would certainly be much more efficacious, if aimed at these manufacturers rather than at the helpless and innocent motor-man, who, like the apocryphal organist of the Leadville church, no doubt "does the best he can."

AN immense water-power plant is being erected in Sweden for the electrical production of chlorate of potash, to be used in the manufacture of friction matches.

EVERY prominent establishment engaged in the business of making and selling turbines publishes a book containing an elaborate set of tables, which profess to give the horse-power, quantity of water consumed, and speed of revolution for each size of the maker's wheel under various heads. Electrical engineers who have had occasion to fit up transmission plants to be operated by water-power, have discovered by sad experience that in many cases these tables are, to put it mildly, a snare and a delusion. It may be possible to "monkey" with a friction dynamometer so as to get peculiar results, especially in testing large powers, but when a turbine is harnessed to a dynamo, a good voltmeter and ammeter will tell the exact truth as to the effective horse-power every time, without fear or favor. The electric test has demonstrated that some of the most extensively used and most extensively bepuffed turbines fall woefully below the pretentious "guarantees" of their builders, not merely in commercial "efficiency," which is often a comparatively unimportant matter, but in speed and horse-power under a given head and with a given quantity of water. If the electric method of measuring water-power succeeds in dispelling some of the vociferous humbug in the turbine business, it will have performed an important service to the manufacturers of the United States.

ARCHITECTURE

Conducted by Barr Ferree.

THE *Architectural Review*, in replying to some comments made in these pages a few months ago on its beliefs and ideas, takes occasion to reduce its philosophy to the form of a Creed, puts it—as it blandly states—in primary form, in order—as we infer—to bring it within the range of our understanding. We highly appreciate the good intentions of our valuable contemporary, and trust that others than ourselves may have profited by the estimate it has formed of our intellectual status. But, alas and alack! this concentration of the Boston mind is not yet sufficiently simple for our poor New York understanding. The *Review* starts out with the statement that it believes "that architecture is an art," and follows this up with the remark that "the principles of an art are best studied in their application to the highest expressions of that art." These two statements, it will be perceived, are matters of belief; they do not rest on any fact, but are themselves the origin and basis of a succession of statements or theories, all of which lead up to the conclusion—the end of the Creed—that "the only thorough education of an architectural student is one in large problems broadly, simply, and theoretically handled." Which is simply a more cultured way of saying what we had pointed out to be the *Review's* ideal,—that in architecture it is better to study theory than practice if one would be a successful architect. But to get back to the fundamental propositions. The first opens one of the broadest questions in architectural theory. Is architecture an art, and if so, what is an art? We do not mind in the least confessing that, when another uses these expressions, we do not know what they mean. We do not know that we would use them ourselves, or, on the other hand, that we would refrain from using them. Only a short time ago a body of English architects published a thick volume wholly concerned with finding an answer to the question whether architecture was an art or a profession, and we do not know that anybody is the wiser for all their reams of paper and pages of print. And so we cannot, in justice to the *Review* or ourselves, undertake to comment upon its Creed, or even reproduce it in these pages, as we once planned to do, unless it explains its fundamental position. And we have no doubt that others—the English architects are a case in point—are equally at a loss to know what any one may mean by the words "architecture is an art."

WE trust that our position on the educational question has been made entirely clear. It is,—as we have often before taken occasion to point out,—that, since architecture is a practical subject, its principles can be gained only from a study of practical questions and problems. We regard the fanciful, unreal problems presented to the students of our Frenchified architectural schools as being quite out of place in a seriously arranged system of education. We are quite unable to understand why *what is not* should be studied in the schools when *what is* is ignored. It was for this reason we took occasion to remark, in the paragraphs to which the *Architectural Review* refers, that the lack of study of business buildings and other practical problems was one reason why there were so many bad things in current work. We are astonished to learn from the *Review* that these problems are not ignored in the Massachusetts Institute of Technology or by itself. As for the latter, we have nothing to say; any periodical is entirely at liberty to publish anything that suits the whim, fancy, taste, ideas or inclinations of its editor. Nor can any statement from this source be questioned as regards the former information. We must protest, however, against the *Review's* assumption that, when we state that unpractical problems do not dominate in the schools, we are speaking without foundation of fact. Some time ago we undertook to collect from the architectural schools a series of the problems given to their students. The effort was not very successful, most of the instructors apparently having destroyed their problems as soon as they had done with them. But we obtained several from different sources, and all contained elements of uncertainty and unreality, with reference to limits of site—as applicable to city structures—or of cost or similar questions which are fundamental elements for the architect in practice. And we think no better evidence of the unreality of such studies is needed than is furnished by the plates printed by the *Architectural Review* itself of theses and other problems worked out by the students in the Institute of Technology. Taking the *Review's* first and second volume, we find the following subjects: "An Academy of Music"; "Design for a Villa"—an utterly impracticable, impossible design on a scale no American would think of building; "Design for a Loggia"—a harmless-enough exercise, but who builds loggias?—"A Memorial Entrance for a Suspension Bridge"—another harmless exercise of doubtful utility; "An Opera-House"; "A Crematory"—on the most stupendous scale, absolutely impossible of execution, because there is no way whereby the funds for such a structure could be had; "A State Capitol"; "A Metropolitan Post-Office"—it ignores the fact that the land on which such a building would be built would be extremely costly and that therefore there would be no room for approaches and wide-spreading buildings;—"An Athletic Club House"—planned with no regard to expense for construction or for land;—"An Official Mansion for the President of the United States"; and "A Railroad Station." Of this list the last is the only one that seems to fulfil the requirements of utility and practicability. But taking the list as a whole, it is impossible to look upon it with satisfaction. The unreal and the unpractical problems predominate overwhelmingly over the real. Boys of twenty are made to design opera-houses and palatial structures no one would dream of confiding to them in real life, and, worse than this, they are taught that architecture consists in such things, and that business buildings, cottages, ordinary residences, and similar buildings are not architecture, or not so much architecture as the fancy things they are trained in. It is no wonder that under such a system current architecture achieves so many extraordinary failures.

THE *Architectural Record* is now engaged in publishing the most extraordiary series of papers on current work we ever remember to have met. It is not often that a writer without a single idea of his own gains entrance to a periodical of any sort, and when we find an eminently sensible journal like the *Record* publishing an extended series of critiques in which the author admits, at the outset, that he is simply borrowing another man's ideas, we rub our eyes with amazement and ask, what next? The articles referred to form an interesting group under the general head of "Wasted Opportunities," the idea being to show architects how, by following certain systems of planning, they might have made a better building, financially, for their clients than they have done. A most excellent notion, and one that might be highly beneficial to the world at large were it carried out in the right spirit. But the writer of the papers has, as we have said, no ideas of his own to employ in his criticisms; he simply takes the general propositions put forth by Mr. George Hill in his paper on the "Modern Office Building," printed some time ago in the *Record*, and to which we have had occasion to refer in these pages, and appropriates them to his own personal uses. Now this is most unjust to all concerned. It is unfair to Mr. Hill to subject his views to the danger of repetition *ad nauseam* which threatens if this series is continued indefinitely;

it is unfair to the readers of the *Record* to palm off another fellow's ideas as your own; it is unfair to the architects criticised to measure their performances by a yard-stick or standard gage, and ruthlessly condemn because they do not come up, not to your standard, but to another's, which you have taken upon yourself to use as your own. A wholesome discussion of the subject would be highly profitable if conducted in the right spirit and with proper appreciation of all the difficulties and circumstances attending the arrangement of a building. But in the present series we have nothing of the sort; Mr. Hill said thus and so, and therefore this and that is bad, a system that probably puts more onto Mr. Hill's shoulders than he may be willing to assume. Incidentally we may remark that it is not necessary to spread over several pages information that is contained in a single brief table, nor should the author of an article, and much less one who owes all he is to another man, give public notice of the fact that he thinks his work is doing good. That may be so, but he is not the one to tell of it. The *Architectural Record* is becoming a great demonstrator. On one page we find the author of "Wasted Opportunities" demonstrating that the planning of our most conspicuous architects is utterly bad. On another Professor W. H. Goodyear is demonstrating that there can be and was no such thing as spontaneity in the origin of ornament. Perhaps it would be better if we could demonstrate, in the mathematical sense of the word, all artistic questions; the *Record* is evidently doing all it can to hasten the day when that will be possible. Verily these be great times for architectural literature.

Poor Mr. Gordon Bennett is having a dolorous time trying to improve the architecture of the American metropolis. His methods are at once characteristic and natural. In his first attempt he went to the most eminent firm of architects in New York, which is to say the busiest, and they speedily supplied him with a design made by an Italian gentleman, who conveniently lived in the sixteenth century, and who, in the natural order of affairs, being dead, could not raise a protesting voice against the wilful and deliberate appropriation of his property. There is no reason to suppose that the results of evil-doing have not followed in the present instance, for admirable as the deceased architect's work was as he did it, there is little satisfaction to be had from its New York reproduction. It was a bold thing to set up an Italian palace front as the outer form of a business building, and many worse things than this have been done without even taking dead men's belongings, but in the present instance the trapozoidal shape of the lot very materially injures a design suited only to a regular plan. But whatever the reason, there is very good evidence to show that the result was eminently distasteful to the energetic newspaper proprietor's mind, for in his next effort to raise the architectural standard of New York, he did not even apply to a firm of architects, eminent or otherwise, but invited the whole earth, architects and builders,—what a commentary on eminent work was that!—to send him in plans and specifications for a sixteen-story steel construction building, for which he agreed to pay the munificent sums of $500 and $250 for best and second best. No incidental expenses in this job, mark you. A more monstrous affront was never offered to the profession, nor could greater contempt have been put upon the gentlemen who had labored so zealously with the work of the deceased Italian gentleman, as aforesaid. And the result was just what might have been expected. Two of the most frightful designs ever produced were obtained as the result of this generous attempt to help architects. It is impossible, within reasonable limits, to give any notion of how these imaginary structures —for it is not conceivable that either of them will be erected—rise and stop, and swell and bulge and start again, and soar and rise, up and up, with pinnacles, towers, dormers, roofs, chimneys, and all manner of strange shapes, fantasies, dreams, idiosyncracies, and aberrations until one is positively amazed that such things could be, and that so much variety could be had for so little money—including specifications and plans, remember. It was quite natural that these creations should have been published in the newspaper conducted by this eminent New Yorker, and quite as natural that they should have been accompanied with an article extolling them and the ideas (?) they represented or attempted to represent. Truly, we may agree with the scribe who describes them, that in architecture "New York is immeasurably ahead of Chicago." For the Chicago eye is, as he sagely adds, "unaccustomed to the great beauties of architectural merit." At this point Mr. Bennett rested from his arduous labors in improving New York architecture, and every one interested in the same good work must be happy because he did so. It is a pity that when so cultured and well-meaning a man undertakes to institute a reformation in so important a subject, he and his advisers should not begin by first learning themselves some few elementary principles of the subject they seek to enlighten befogged people about.

THE National Academy of Design is in a great stew, and all because, like Mr. Bennett, it has undertaken to raise the architectural standard of New York by erecting a new building for itself. It feels, and perhaps rightly,—it is the best judge of this itself,—that it needs a new building, and that its present structure must be made over again or a totally new one erected. Apparently it inclines towards the latter view, of which, as in all questions of this sort, it is the best judge. But instead of proposing a new building that can be erected with its present funds, or with funds readily obtainable, it is fascinated with an elaborate design prepared by a gentleman who has come forward recently as the author of a series of designs of elaborate, expensive, and almost too-costly structures for this hard, money-making, unartistic age of ours. Of the design itself nothing need be said, the published pictures in the daily press being too inadequate to enable one to form any sort of judgment. It is much more to the point to consider the financial elements of the problem; and when a perfectly satisfactory structure could be had for half the cost of the proposed palace, or even for less, it is quite impossible to sympathize with the difficulties which beset the Academy because it has not the wherewithal to build a great building wholly beyond its present financial abilities. This is a notable example of a method not uncommon in ordinary practice of designing a building irrespective of conditions, and then trying to get the conditions to fit the building. A more logical system, certainly, would be to study the conditions first, and then make the building fit them. There is no encouragement in the fact that a body of wise men, like those forming the Academy of Design, should follow an irrational and ill-advised method in their architectural efforts. The hope is expressed, we believe, that some patriotic New Yorker will seek to emulate some of the generous citizens of Chicago in donating the whole $2,000,000 needed for this new building. While the newspaper cuts are especially unfit for serving as a basis for judgment, we should be exceedingly sorry to see any one spend two millions for a structure of so ordinary an elevation as that put forth in this case. Nor do we see any reason for telling the public that it was designed in Paris, because the author was a pupil of a French government architect. Has its author a series of stock designs, composed in his student days, that he brings out before the public whenever an apparently fitting opportunity occurs? We fully believe in the architectural student's busying himself with the practical problems of real life, but, bless our soul, we would not have these youthful essays drawn out of portfolios when an actual or possible job comes along.

AMONG the most important factors in the art development of America the Metropolitan Museum of Art in New York stands easily first. The richest and most important museum in America, containing collections that compare favorably with many of the large collections of Europe, and which in one or two instances are the finest in the world, it naturally attracts students from the whole country, and is thus a national as well as a New York institution.

The trustees have long made it one of their especial cares to utilize the educational value of their collections to the utmost, and the schools of the Metropolitan Museum are wide and favorably known. Of these we need only here refer to the architectural school, which possesses some positive advantages of its own and which really has a distinct position among the architectural schools of the country. With so admirably conducted a school as that at Columbia College close at hand, it would have been an unnecessary duplication of resources to conduct a school on established models. Professor William R. Ware, who, happily for the museum, joins the chairmanship of its committee on schools with the professorship of architecture in the School of Mines, has recently arranged the architectural courses for drawing alone. It is thus possible for the young man who is unable to pass the somewhat rigid entrance examinations of the collegiate architectural schools, to spend one or two years in the museum school, during the whole of which time he has thorough and extensive practice in drawing, while making up, if he wishes, such studies as he may be deficient in. At the expiration of his course in the museum he can enter the School of Mines or any other of the architectural schools, and, if he has worked hard, he can well save a year through his preliminary studies; or he may, if he chooses, go directly to an office, where his long apprenticeship in drawing at once gives him a decided advantage over other young men who may be entering at the same time. And the Museum school does more than this, for the opportunities for architectural study in New York are so abundant that an earnest student at the Museum can readily make up its lack of historical teaching by extra lecture courses, and thus, at very small expense, gain almost the entire advantage of the ample facilities of the metropolis in this department. The present is the second year during which the Museum schools have been conducted on this plan, and there is no question of its success. Young men are given the opportunity to practise drawing on the same system as that pursued at Columbia, and the Museum is enabled to use its rich collection of architectural models and casts in the best possible way at a minimum of cost to itself.

THE *American Architect* is celebrating the close of the World's Columbian Exposition by publishing a review of it composed by a gentleman who somewhat naturally regards the fact of having attended it almost daily as a special qualification of fitness. Perhaps it is, but what shall be said of a writer who, undertaking to describe the Fair critically, introduces in an early stage of his description a remark to the effect that not only does the Administration building "tower above all its surroundings, but like few other buildings that have been erected can be almost said to tower above criticism"? The critic naturally adds that "It is the apotheosis of classic and renaissance architecture by one of the great living masters." We have no wish to say unpleasant things, and the intentions of the *Architect* in publishing this review are most laudable, but certainly these sentences we have quoted exceed in silliness all the other foolish, unwise, absurd and senseless remarks about the Fair that we remember to have met. And our acquaintance with such remarks is not limited. It is writing such as this which makes Americans so ridiculous in the eyes of soberer-minded foreigners, and it is just this spirit which has deprived American critical writings of the Fair and its buildings of all value and profit. But we quite agree with this author when he says that the Administration building must have been at once "conceived as a whole, and is not the labored result of repeated studies, for the executed building does not differ materially from the original sketch." The reasoning is bad, for few architects rush into print with their preliminary studies, and few important changes are found in carefully-studied buildings after the published drawing is made, because it usually represents the finished work of the architect. But we think it quite likely that had further study been given to the Administration building, some very manifest improvements would have been made in it.

RAILWAYS

Conducted by Thomas L. Greene.

ONE illustration of the pressure of declining rates upon the finances of railways is shown by a fact noticed by few and not heralded from the car-tops by the companies themselves, namely, that two first-class dividend-paying railways, for the fiscal year ending last June, charged to capital a large part of the cost of renewing their equipment. Had this cost been charged to operating expenses, where it belonged, the results of the year as stated in the income accounts would have shown that the dividends paid had not been earned.

Experience has taught us that every company or manufacturer in active business must allow for depreciation. The plant may be yearly depreciating in value, while the machinery must at intervals be renewed or replaced by more modern inventions. Exactly what amount should be allowed for this wear and tear will differ in different lines of business. But when the probable sum is found by trial, it should be spread over the term of years by the deduction of a proportion of the amount each year from the earnings before the surplus is divided among the shareholders. By universal consent the railways reach the same result in another way. They do not charge off a specific sum each year for depreciation, but in theory make the necessary proportion of repairs and renewals annually, putting the cost in the operating expenses, while manufacturing companies state the yearly proportion of that cost as a separate item. As a certain portion of railway equipment wears out each year, the plan works well when faithfully carried out. This policy has its dangers, however, for roadbed and equipment may be neglected until a large sum is found to be needed for economical working. Sometimes, when pressed, a company will repair and renew, but in some way manage to charge the cost to capital to be covered by the issue of bonds or stock. The practical man has a soft place in his heart for the perplexed manager who stands between the stockholder or bondholder and the public, and often can satisfy neither. Yet it is also true that if renewals are not paid for from earnings, the shareholders will one day find a next-to-worthless plant on their hands. One of the simple tests applicable to companies which are suspected of presenting a false prosperity by this erroneous charge of equipment renewals to cost of property, is for those interested to procure copies of the annual reports for several successive years. A brief comparison of the numbers of engines, passenger- and freight-cars in service from year to year will show whether the lists have increased, and to what extent. A glance back at the charges to capital (which ought to be set out in full in each report) will quickly reveal whether the increases in the equipment in service agree with the numbers charged to capital account. If they do not, an explanation is in order.

OF course this method is not applicable to the roadbed and track. The proper plan in such cases, where an inspection of the property is not desired for any reason, is, as before, to obtain copies of the annual reports for as many years as possible. A table can then be made for each year of the average operated mileage (not the mileage at the close of the fiscal year) and of the expenditures put down in the reports under the head of maintenance of way and structures. Dividing one set of figures by the other will give the amount spent annually per mile, which is the only proper method of comparison. These amounts per mile can then be compared with the amounts charged to this account by other roads situated in the same territory. Care should be taken to select railways which are similar to the one under examination. Averages of groups are of little value unless the conditions of all are substantially alike. Averages for the whole United States are useless. The New York and New England, for example, should not be compared with any road out of New England, nor (as was once done) with the averages of the Massachusetts railroad commission's report for the whole State, which included the rich Boston and Albany and the Old Colony. The road in question is most fairly judged by comparisons with the Fitchburg, the railway most nearly resembling it. If these sums of road expenses per mile vary greatly from year to year in the reports of the same company, it is a matter for further investigation: there may be some good reason for at least a part of such variation. A larger volume of traffic may compel some additional expenses in that year or may justify the spending of larger sums than usual on the property.

Another reason for variation in expenses for maintenance and renewal between companies or between different annual reports of the same company, may be found in the different practice of railways regarding betterments. The English theory is that every item of expenditures which in the least adds to the original cost of the property should be charged to capital and paid for by bonds, while the surplus resulting in each year from the deduction of operating expenses (thus narrowly defined) from gross receipts should be paid in full to shareholders. Even in England this theory has lately received some criticism. Financial writers have begun to call public attention to the enormous and increasing capitalization of English railways, which is now an average of more than $200,000 per mile, while American lines as a whole show only about one-fourth of that sum. The question is asked in Great Britain whether the railways can hope to continue earning returns on this augmenting capital if British trade should seriously suffer in the future. Ultimately this theory will have to be abandoned.

ALTHOUGH the theory has never been firmly held in the United States, still the influence of the large number of foreign holders of our stocks and bonds has had its effect upon American management. As applied to American railway affairs the theory is dangerous. Traffic is comparatively steady in England, but fluctuates greatly in the United States. It must of necessity be that the business of a young and growing country with many undeveloped resources, is speculative in the good sense of that word, and that railways must follow the ups and downs of general business. If a company during a year of prosperity should put none of its extra profits into its plant, it would not find its property in excellent condition and capable of withstanding the strain of a poor year, when adversity came, as come it certainly will. A general rule more applicable to railways in the United States would be to charge to capital only such improvements as increase capacity or permit a direct return in earnings. This rule would not always allow of a charge to capital for the extra cost of replacing a wooden bridge by an iron one, for example, a custom almost universal and defended on the ground of a permanent increase in the value of the property. But a railway, be it remembered, is of no value except for transportation. The whole plant is to be appraised, not as real estate, but only according to its earning capacity. In short, its net earnings, fairly stated, constitute the only real criterion of its value to bondholders or stockholders. Consequently the proper distribution of the cost of small improvements should be governed by the fact whether the net earnings are or are not helped thereby. But iron bridges permit longer and heavier trains, some one will say. Whenever that is true, then as a matter of broad policy it justifies the charge to capital to that extent, but it does not follow that every bridge should be so treated. And indeed, where traffic is increasing but net earnings are not growing in like proportion (and many roads find themselves in that position), there are always increases in imperatively needed facilities which rightly demand the expenditure of money to be charged to capital to the full extent of the proportion of increase in profits, without further charges for mere changes in plant which involve no gain in net earnings. However, only a general principle is here contended for. The circumstances of each road must be considered in deciding upon a proper policy; for circumstances alter cases.

THE decision of the United State Circuit Court of Appeals on the Texas and Pacific case closes the matter so far as the California rates of that road are concerned, but leaves the general question as open as before. The Texas and Pacific took California shipments from Europe via New Orleans at through rates which give that road but a fourth as much as its proportion on local shipments from New Orleans to San Francisco. The company defended itself against the order of the Interstate Commission by the simple argument that if it did not accept such European rates and proportions, the freight would go to California all water. The court declined to decide the general question whether differences in shipment originating in Europe justified a difference in treatment by American rail-carriers who formed but part of a through route. Declined in set terms, that is, but practically admitted the right of the railway to make a reasonable difference. "That some dissimilar conditions justify dissimilarity in rates is true. That remote dissimilarities of condition justify any dissimilarities which the carrier chooses to make, is not true." It must be acknowledged that the proved differences on the Texas and Pacific were so great as to lead to the conclusion that the import rates were below cost, or the local rates extortionate. The court therefore took a common-sense view of that case.

But the equalization of European rates on imports and exports through all American ports is a hard problem. Some saving in handling flour from Minneapolis to Liverpool, over flour shipped to the Atlantic seaboard and then reshipped, must be conceded. Further, we must acknowledge that since Liverpool fixes the prices on wheat, any saving in transportation is a benefit to the northwestern grower. The seaboard exporter, by the changes in the method of carrying and selling grain, has usually been able to offset the possible advantages of a lower through rate and so to keep his trade. On flour, however, the European shipments are made directly through at a slight saving. If we say, as many do, that the railway rate should be the same whether the flour is consumed in New York city or Liverpool, the traffic man asks what an American road should do, if the Canadian Pacific should take flour from Minneapolis to Liverpool via Montreal at a reduction under the rate via Boston or Philadelphia? It is a hard question. The Texas and Pacific decision would seem to say that at least violent differences between American and foreign shipments are unjustifiable. We are not much nearer a solution than that.

IT is always refreshing to find the courts taking a sensible view of transportation matters. The legislature of Massachusetts passed a law making mileage tickets compulsory and interchangeable upon all roads within the State. The illegality of the act seemed so clear that one company declined to obey, its action being now upheld by the Supreme Court of Massachusetts. The court took objection to several points. The law in effect authorizes one railway to determine the condition and terms upon which another railway shall transport passengers, and that, too, without the latter's knowledge or consent. Then, again, the law would deprive a company of its right to receive its fare in money and in reality compel it to become a creditor of a railway with which it might have no dealing, and which it might not be willing to trust because of actual or probable insolvency. In effect such a law would amount to confiscation, because it would be taking private property for public use without compensation. The government, whether State or national, cannot deal with private corporations unjustly. There was a dissenting opinion in this case which did not amount to more than the saying that mileage tickets were demanded as a public convenience, Cheaper fares for certain kinds of passengers, or upon certain trains, is often not an unreasonable request, but is one which the railways have not yet succeeded in solving. While the Massachusetts act was clearly illegal and not to be defended on any ground, yet it serves notice upon the companies to address themselves to the problem, to the end that some way to meet it may be found by the railways themselves. In a recent address President Ingalls said that through passengers carried in expensive trains did not pay enough, while way travelers, considering their accommodations, paid too much. In what way can we arrange to charge each passenger his proper fare?

A LEGAL question of some importance seems now in a way of settlement. Several men prominent in Ohio bought on margin the stocks of three small coal roads and formed the present Columbus, Hocking Valley and Toledo. They put upon the consolidated road a blanket mortgage of $8,000,000 for the declared purpose of double-tracking the road and otherwise improving the property. It is claimed that under the pretence of buying coal-lands from themselves they practically reimbursed themselves for the stocks first purchased by turning these new bonds over in payment for the land. The company tried several times to throw off the mortgage, but was each time defeated, because the officers of the road acted within their authority in creating the mortgage, holding the stock of the company at the time. Recently, however, a suit brought by an outside party interested in the road asked for a settlement with these old officers, which suit the New York Supreme Court has upheld in spite of the good technical defense. Every day makes fraud in railway finance more difficult and more disreputable; so far as fraud was present in this old matter it is for the interest of all that it should now be brought to account.

THE receipt of the English returns to parliament on the accidents on British railways for the first six months of 1893 is a reminder that thorough investigations into all accidents and public reports thereon are peculiarly within the province of our State railroad commissions. Minute investigations into each accident in England are undertaken under the orders of the Board of Trade (a semi-public body) by the officers of the royal engineers. Their findings, with the testimony, are made public, though the board has no further power of coercion. Nevertheless the censure (if censure there be) of an impartial member of the engineer corps of the British army has great weight. No English railway likes to have it reported in print (for instance) that it kept a signalman on duty for, say, fourteen consecutive hours, and that his mistake which wrecked a train was the result of too long service; or that the company was blameworthy in its care of the track or in any other particular. English railway discipline is high, and very few accidents, compared to the number of trains, are reported. It would be a great advantage in the United States if we could have had expert examinations made into the real underlying reasons for the shocking accidents of the last two months. If the management was negligent, the fact should be known. If the pressure for cheapness was the real cause of the accident, the public should know it, and also whether the rate or fare problem probably led to the unwelcome economy.

A MAJORITY of railway-men look for a dull winter. The World's Fair has contributed to swell the passenger earnings for the summer and fall and thus for a time to counteract the decline in the freight traffic. For a while the traffic may be light by contrast. These same men are also of the opinion that traffic is in sight, though it may not immediately move. In short, all the evidence favors a return to good business and fair prosperity. But when? The heavy losses in earnings on the Union and Northern Pacific railroads afford one more example of the dependence of the railways upon the business prosperity of the sections served; as traffic has declined on these roads, so will it increase again when confidence sets all wheels in motion.

MINING & METALLURGY

Conducted by Albert Williams, Jr.

THE revival of gold-mining in the far West and on the Pacific coast has been remarkable. It is true that in large part this has been forced by the decline in silver-mining, which has caused capital and men formerly engaged in that branch to turn to gold-mining. There is a certain kind of capital which seems inevitably to seek investment in precious-metal mines, and when discouraged in one direction it flows naturally to the other; while the large number of miners thrown out of employment by the closing of silver-mines or reduction in force had to find employment, and they turned to prospecting for gold, or taking up abandoned gold claims or "leasing" on others. The result has been a considerable development in several quarters, notably in the Cripple Creek gold-district in Colorado, where a veritable "boom" has set in. So far the total production from that camp has not been very large, but there are about eighty mines and prospects that have each yielded something, spread over a tract about twenty miles square. It is not unreasonable to believe that with so extensive a showing the future output, when the mines are better opened, will be very heavy. The camp is only two years old now.

It was expected that by this time arrangements would be made to reopen many of the great hydraulic placer mines of California under the new "débris" law; but as the Senate failed to confirm the appointments of the commission having the matter in charge, there is a question as to their authority to issue permits, and the anticipated revival in this branch of gold-mining is for the time delayed.

SILVER-MINING is in a very depressed state, but hardly any worse off than for many months past. Foresighted operators long ago had made up their minds that Congress would annul the silver purchase law, the almost sole prop of the market, and had discounted the outcome, just as had the bullion-dealers. So when the final decision of Congress was announced, it affected prices very little and mining not at all, for it was already at about the lowest possible ebb. Indeed, there has since been a sort of feeling of relief that the worst was over, and, if anything, there is a little more life. At this season of the year, without regard to other causes, it has been customary to close down many of the mines at high altitudes on account of snows. This year, it is true, not very many operating mines were left to suspend. But it is a fact that after Congress had adjourned a few silver-mines actually reopened. Those which produce a considerable proportion of gold in addition to their silver are of course in the best position to stand hard times. The exclusively silver-mines, with very few exceptions, will find it extremely difficult to make both ends meet under existing conditions. A curious feature of the situation is the sudden and artificial rise in the quotations for Comstock shares, which suddenly and without apparent reason jumped 300 per cent. and more after the silver purchase law had been wiped out. Ill-natured and suspicious people hint that this was in view of the approaching Midwinter Exposition at San Francisco, and the belief that a lot of Eastern and foreign visitors could be coaxed into the same old game and absorb stock unloaded upon them at good figures.

WITH the coming on of winter each year the question of short-weight coal is brought to the surface anew. In New York city there has always been complaint on this score, and while it may not justly apply in the case of the larger dealers, it certainly does in the case of those who supply the poor in small quantities from peddling wagons and by the bucket. For two years the New York Coal Exchange has been making strenuous efforts to abate the nuisance on the one hand and to verify the honesty of dealers on the other. Two plans have been proposed: (1) that the Exchange should employ its own inspector to weigh the coal on loading at the yards, this on agreement with each individual dealer,—and it is perhaps a little significant that a very considerable number of dealers declined this proposition; (2) the other plan is that the Exchange's inspector, on request of the purchaser, should weigh the coal on delivery, at a nominal charge, say 5 cents a ton, the inspector to be provided with portable beam scales, etc., and also test other scales. The Chicago Retail Coal Exchange has a similar system of inspection. Of course there are in many large cities official public weighers, but the amount of good they do is problematical. When, however, a coal exchange goes seriously to work to protect not only the customers but also the good name of its honest members, that is something like business. This short-weight question directly concerns the coal-producers. There is a perpetual wrangle over prices, and consumers are always grumbling, and especially in the case of anthracite there is the annual complaint that prices are too high. There is really very little profit in coal-mining at present; in fact, some of the large concerns operated in connection with railways are often run at a loss. Between miner and consumer it is easy to account for the advance, which is distributed among railway haulage or canal freights or both, one or two middlemen's profits, and in some cases the cut from the long ton of 2240 pounds to the short ton of 2000 pounds (which too often is found to be 1800 pounds or so).

THE coal-mines of Missouri, like most of those throughout the West, have the advantage of being shallow, and thus saving in average hoisting and pumping expenses. Most of them are less than 200 feet in depth. One of the deepest is in the Randolph shaft, in Ray county, 420 feet to the coal. The deepest mine is near Hamilton, in Caldwell county, about 500 feet. There are seams at greater depth, not yet operated.

AT last what appears to be a practicable method of coaling war vessels at sea has been introduced, and was lately experimented with by two United States ships off Sandy Hook, both moving at about four knots and a hundred yards apart. The speed could have been increased, but it is doubtful whether the system in its present stage would be successful in a heavy seaway. A trolley line connected the two vessels, and over it the coal was transferred in sacks—not very rapidly, it is true, but there was no reason why a second line might not be used. This is a much more important matter than may at first glance be apparent; for the new device promises to solve the problem of coaling stations for our navy; it will enable it to be supplied with American coal, carried to any prearranged point by colliers from home.

THE close economies demanded in present iron blast-furnace practice have brought about some singular results. For example, it has been stated that in some of the Scotch furnaces, which have had to be operated on very small margins,—and of which, by the way, many have recently blown out,—the pig-iron produced has been really the waste product, while the tar and tar products saved have been the mainstay. About half of the Scotch furnaces have been "capped," and the heated waste gases conveyed through miles of condensers and the products saved. It is a rather astonishing fact that in some cases the subsidiary plant to reclaim the waste products has cost more than the blast furnace itself. More familiar examples of blast-furnace economies are the utilization of waste heat for boilers and to heat the blast, and the almost innumerable plans for utilizing the slag, some of which are in successful application; but a mere enumeration of the many directions in which great or small savings are sought would require a long article, while to discuss them fully would involve the making of a book much larger than the standard complete treatises on iron making of a few years ago. In some respects this complexity of side issues that have to be considered is somewhat discouraging to the metallurgist and the projector of new works, for instead of the simple problem of taking so much material and turning out pig-iron of a certain quality and quantity, at the lowest direct cost, the industry assumes the aspect of a most complicated commercial business, in which there is no end to the details. And every other branch of metallurgy is being forced by competition into the same lines as the iron industry.

AN important placer-mining undertaking is reported to be on foot in northern California. It is proposed to mine the bed of the upper Sacramento river in Shasta county for a considerable distance below a dam built across the stream at Redding. The *Shasta County Democrat* says that the plan is to use a shear-dam a local electrical company has been putting in, which is large enough to carry nearly all the water in the river at this season of the year. By accomplishing this—and competent engineers say it can be done at a reasonable cost—they will be able to work the rich gravel below the dam. The *Democrat* says that there is no question about the gravel being rich in gold, for miners who have worked in the gravel for several seasons past in water up to their waists have been and are now making big wages.

In Colorado and elsewhere a number of river-bed workings have been opened during the last season or are in prospect for the next. Old miners in almost every placer mining region have in mind some pet scheme for getting at river beds by diverting the water or by running bed-rock sluices to dispose of accumulations of old tailings, and doubtless there are many places where operations could be successfully carried through now that would have been hopeless in "early days," when it was so much harder to get capital for undertakings requiring so much time and outlay before realization of profits.

MINING-SHARE speculation is by no means dead, but it is badly indisposed, notwithstanding the recent flurry in the San Francisco shares. Sometimes it is on a scale that is rather pitiful, even if absurd. For example, here is the report in a Denver newspaper of the transactions for the day (taken at random) in the mining exchange of that city. This exchange, it should be remarked, put up a $300,000 building, which it does not now own, and thinks a good deal of itself. So evidently does the newspaper about to be quoted. There is not room here to do justice to its eloquent display head, but it reads as follows: "A Strong Market! A Good Many Stocks in Demand that Can't be Had.—[Susie S.] Stock Goes Up To-Day.—[Araminta] Also a Favorite with the Brokers.—[Snodgrass] Wants [Poverty Flat] in Big Bunches.—The Features of the Market both Locally and at Colorado Springs.—Total on 'Change To-day was 14,000 Shares." Fourteen thousand shares! That certainly has a large sound; but as they mostly went at from half a cent to four cents a share the total foots up just $308.25 for all of them except one block of 500 of a $2.15 stock, which brings it all up to $1383.25 for the day's work of the exchange. It would be painful to figure on the commissions.

TWO decisions in relation to the liability of mine-owners in case of accident to employés have recently been rendered. In one case the United States circuit court of appeals, eighth circuit, has ruled that coal-mine foremen and laborers are fellow servants; that is, that the "foreman" in an eastern coal mine is not a responsible officer of the company in the same sense that the "foreman" of a western gold or silver mine would be. This is in accordance with the common understanding of the word, which has a different significance in different localities; but it is a nice point in definition. The ruling is:

A foreman in a coal-mine, whose duty it is to direct ten or twelve men what work to do, and to prop the roofs of rooms with timber; to inspect them and see if they are safe; to drill holes in the face of the rooms, charge them with powder and fire them; but who is subject to the orders of the pit boss and the superintendent, is the fellow servant of a laborer under his direction who is injured in performance of his duty, in shoveling and removing coal and dirt, and assisting the foreman in his work.

In a case appealed to the supreme court of Utah, an action against a mining company for injury to an employé, the point at issue was the duty of the company through its officers to warn its men of possible danger unknown to the latter. The court held that:

In an action against a mining company for personal injuries received by an employé, by rock falling down a manway in which he was working, where he claimed that the fall of rock was caused by blasting in a tunnel which was being extended toward the manway, evidence as to the length of time which was required to complete the tunnel, after the accident, was admissible as bearing on the proximity of the blasting to where the injured person was at work. It appeared that the fall of rock could have been prevented by proper precautions on the part of the company; that the man was ordered to work in this manway, though it was not a part of his duty to do so; and that the foreman knew the place was unsafe for one unaccustomed to work there. There was evidence that the fall of rock was caused by the blasting in a neighboring tunnel, of which no warning was given, and the employé was unaware of the proximity of this tunnel. A verdict for the employé was justified.

SOME months ago the press dispatches from a Mexican mining district announced that the mine foreman, charged with having been responsible for a fatal mine accident, had been held for murder. How the trial resulted we have not been informed, but evidently they have a summary way in Mexico of treating this question of responsibility.

AN unusual, though not unprecedented, accident occurred September 28 at the Mansfield iron mine, near Crystal Falls, Michigan. The working levels were run directly under the Michigamme river and parallel with it for several hundred feet. The upper level was thirty-five feet below the bottom of the river. Five lower levels, parallel to the first, made a total depth of 425 feet. The upper levels had been stoped out, leaving timbers and ore pillars to carry the superincumbent weight. The accident is thought to have been caused by a giving way of the timbers on the fifth level, allowing those above to follow. Finally the topmost ore and rock caved, and the river poured in, filling the mine, drowning most of those not crushed by falling rock. Of 48 men then on shift underground, 20 escaped and 28 perished. The mine is hopelessly wrecked, and the 250,000 tons of ore supposed to have been in sight are lost. This is one of the many cases as to which it is hard to determine whether the accident was or was not preventable. In the strictest sense, it could have been averted by leaving more "back," larger pillars, and heavier timbering. Yet the mine had been carefully surveyed and had been under constant inspection. The management, fully realizing the danger, cannot be accused of having had so little sense of self-interest as to deliberately invite disaster. Yet the accident did occur.

ALUMINUM seems to be on the eve of making one step more in the direction of lower prices, and consequently of increased use. The latest advance—for in this case a decline in price can be properly termed such—is not a very large one to be sure, but it is in direct line with the continuous series of improvements that have marked its history, and brings just so much nearer the twenty-cent mark which appears to be the limit attainable under systems of metallurgy at all like those now applied in its production. It is now announced that a prominent producing plant in Switzerland is about to place its product (aluminum, not aluminum in alloy) on the market at forty-five cents a pound, which figure the American works can probably meet under present conditions and with their present facilities. It has been pointed out that this figure, taking the low specific gravity of the metal into consideration, places it in matter of bulk as actually less than tin. These reductions cannot be expected to go on by jumps as during the period when the price came down from $7 to $1 per pound, for the margin for reduction is gradually narrowing. Until some now unknown method of reduction is introduced, the successive drops will be small. In order to bring the matter into square competition with iron and steel, it will have to be made by analogous methods, and a simple direct smelting with ordinary fuel on the large scale is not yet in sight. This, formerly considered a wild and visionary dream of enthusiasts ignorant of chemical possibilities, may yet turn out to be feasible, though the way to it is not yet discovered. At least it is not safe to assert that such a thing is impossible. Meanwhile aluminum, if somewhat disappointing as the "metal of the future," is steadily gaining ground, and metallurgists have reason to be proud of the progress already made in the face of difficulties not so long ago thought to be insuperable.

THE following account of the method adopted for extracting the ore from the iron mines of the Low Moor Iron Company, in Virginia, is given by the *American Manufacturer*.—"About two miles from Low Moor furnace, the company operates, on the caving system, large iron mines in a fine seam of ore running down through the mountain. The miners commence on the top of the seam and take a cave of 12 feet, cribbing up the top as they go. When they have finished that cave they come back to the place of beginning and lay a floor on the bottom of the former caves and then start under this floor and take out 12 feet more. This is repeated until the bottom of the seam is reached. A number of different ways have been tried for mining this pitching ore seam, but this method has proved the most economical and successful. This seam of ore cropped out at several places, but it was thought best to locate at the lowest point. A shaft was sunk 150 feet, out of which the ore is hoisted. This also affords fine drainage, and the mine is kept comparatively dry. There are two fine shafts and two drift openings."

IT is reported that cinnabar has been discovered at Lynn, Mass. This adds one more to the already numerous localities at which this ore of quicksilver has been observed in the United States, and yet of all of them only the California deposits are now productive, though an occasional flask has been produced in Oregon. As to the newly reported discovery, it may be said that the New England States furnish specimens of almost all known minerals, one reason being in the natural character of the country, another in the care with which it has been observed by so many competent mineralogists. With the present restricted demand and low prices for quicksilver it would require a very large and rich cinnabar deposit to make a mine.

A SMALL portable apparatus for making accurate concentration tests has been invented and successfully used. The idea is to avoid the expense of shipping large lots of ore to a concentrating mill for a test run, or to a testing laboratory to determine whether the ore will concentrate and what system or machine would best serve. Such an apparatus can be taken wherever a light buggy or buckboard can go, and should nearly answer the same purpose for preliminary testing as a full-sized concentrator, which is a bulky machine, seldom weighing less than a ton, and with most styles requiring some skill in setting up and adjusting.

ACCORDING to a ruling of the Interior Department publication of notices regarding mining locations, mining land patents, etc., must be made in a newspaper of general circulation and the nearest to the place where the property in question is situated.

THE statement is made that every gem stone known to jewelers has now been found somewhere in the United States. Yet Mr. George F. Kunz's estimate of the value of the precious stones of American production marketed in 1892 is only $188,000. Without doubt there is here a promising field that has hardly begun to be occupied.

MACHINE SHOP PRACTICE

Conducted by Albert D. Pentz.

WHILE the speed for cutting iron and steel should be low, the feed may be much greater than most workmen believe. If a planer has the power and rigidity, and if the part in operation be solidly upheld, more metal can be removed with a fast feed and slow speed than if the conditions were reversed. Cutting cast-iron at fourteen feet per minute and feeding one-tenth of an inch per stroke is perfectly practicable, and it is more economical than a speed of twenty-five feet, cutting five-hundredths of an inch. These remarks apply to turning, gear-cutting, and milling, as well as to planing.

IT is well known that the bronze made of nine parts of copper and one of aluminum is of the color of gold and will not tarnish. It is of a tensile strength equal to steel. At this time this metal can be produced in castings for about the same price that crucible steel costs, and the castings can be made very true to pattern. Why do we not use it and save the expense of working forgings to shape? And why do we not use it for the improved artistic effect its color will give?

IN calculating how to reduce the cost of an article of manufacture without curtailing its efficiency or appearance, it is quite as necessary frequently to modify the parts of the article itself as it is to design improved tools and fixtures. Often two or more pieces may be consolidated into one. Shapes may sometimes be made different to facilitate the machining, and patterns usually can be changed to simplify molding. A manufacturing engineer constantly has these things to take into consideration, and when all of them are properly taken care of, results begin to show at once.

THE greatest factor in profit-getting in modern manufacture is that all the regular work shall be done by the piece and not by the day. Men who work by the piece have an interest in new tools of rapid execution, and they study new methods to facilitate the completion of their operations. Hence it is suggested that such concerns as still manufacture standard articles by day's work should try piece-work. Without doubt it will be more satisfactory than it is to put boys and girls on men's work. With piece-work, too, a man must do good work to get paid for it, for if he does not make satisfactory products he loses his labor and in addition must pay for the material he spoils.

PLANERS driven by friction-clutches have not yet been perfected. The writer believes that this is the correct principle, but that the proper application of the clutch has not been made. Doubtless if the speed of the friction surfaces were proportioned to the platen speed at not less than 60 to 1, and if the friction should be upon elastic surfaces properly arranged, the result would be successful.

DE GREE tried to keep his work in his head and of course he forgot some of it. Then he took notes of everything to such an elaborate extent that he could not make sense of it all when the notes were needed. Blunt, who watches him closely, noticed this and delivered this little lecture:

"Your trouble is that you don't act quick enough. Oh, you work hard enough; I am satisfied of that, but you take either a mental note or a memorandum of a thing you should act upon. The way you take notes merely procrastinates the thing you want to do. You found a casting that was unsatisfactory and made a note of it, instead of sending at once for the pattern-maker and ordering him to correct it. That then would have been done as far as you could do it, and your note should have been one to remind you later to see that the pattern was changed as you had ordered. You will still find this much the more satisfactory method,—it will save your legs and your head as well."

MOST of the small steel castings are merely malleable iron treated with animal charcoal. The operation is about the same as case-hardening, as far as the heating is concerned, but it is continued longer and not quenched in water in most cases. If the charges for such steel castings are much higher than for malleable iron, it may pay to experiment on them in this way.

UNCAST steel, blistered steel, and shear steel are names for raw steel before it is cast into ingots for the purpose of making it homogeneous. This product has fallen into disuse unjustly of late years and should be rehabilitated as a material for many parts of modern machinery when a hard surface over a tough interior is desired.

THERE is no subject more valuable for the study of machinists than the flow of malleable and ductile metals. A malleable metal flows somewhat differently from a ductile metal, and this difference must be understood in making tools to operate such metals. An extremely malleable metal, such as gold or iron, may be lengthened or widened indefinitely by hammering or rolling its surface. This hammering pushes or kneads the mass at each blow, so that while it will contract in thickness between the hammer and the anvil, the amount of the metal thus displaced will flow away from the point of the flow in the direction offering the least resistance. It is obvious that a piece of metal thus hammered will become thinner, wider, and longer. Now, suppose we take a cubic inch of soft iron—such as is called open-hearth steel—and place it cold upon an anvil, cover it with a swage, and strike it with a sledge of certain weight until it becomes "set" and refuses to flow any more with the application of that amount of force. The top and bottom faces will then be found flat and larger than before. The other four faces will be found to be convex, and the four upright corners will be rounded. This indicates that the metal flows toward the sides rather than toward the corners, and that the friction under the flat swage and on the anvil has prevented these two surfaces from flowing as much as the interior of the mass. The heavy weight of the sledge also modifies the flow, the metal in the cube being driven all the way through. A light hammer applied directly to the surface would, on the contrary, expand that surface alone so that the top edge would hang over the sides, as seen on the heads of cold-chisels after considerable use.

In the making of dies and similar tools by hammering or pressing cold metal into shape, the laws of flow need to be learned. The general ideas may be gained by reading, but the practice must come by experience. A slow-moving press will yield results where a quicker one will fail entirely, for cold metal flows very slowly. A heavy drop-hammer ram, falling a few inches and delivering a blow of three tons, will do more and better work than a lighter one falling ten feet and delivering an equal blow. This may be due to the speed of impact which develops heat from a large part of a blow rapidly made. Hence, in embossing, straightening malleable castings, and all manner of press work where the operation is that of hammering or compressing material to shape, the operation should be as slow as is practicable, and with the greatest possible force on each blow. Peening is an indication that cast-iron will flow to a limited extent. This operation should be varied, however, by using the flat face of the hammer alternately with the peen.

DUCTILITY depends upon the tenacity of a metal. Thus if the end of a piece of soft iron wire be reduced 1 per cent., and this small end be entered through a drawing-die which it fits, all the remainder of the wire can be drawn through, reducing its size to that of the die and elongating it proportionately. In this case the small end must pull so hard as to work all the particles composing the wire into new relations with each other. First, the smaller section is drawn forward. This presses the excess of the larger size backward and inward, causing a flow. Cartridge-drawing and other similar operations depend upon ductility. Here, again, speed must be used with caution.

THE operation of burnishing makes a soft metal flow on the spot where the burnisher is applied. This fills up the loose grain to an even surface, makes it smooth, and gives it what polishers call a "color." A rag-wheel burnishes also, and gives color, causing the surface to flow about the same as a burnisher does, but with greater force, for such a wheel can cause a flow on the surface of hard steel, nickel, and other hard metals.

MACHINISTS will find copper to be the most handy metal in one particular,—it can be beaten cold into all manner of forms. Coppersmithing in an ordinary sense requires little or no practice by any one familiar with the use of the hammer and with the flow of the metal. In making small machine models for exhibition, in experimenting on difficult shapes where the experiment has not advanced to a stage which permits dies to be profitably made, and in the making of light hollow patterns, this metal thus formed will be found very valuable.

CAST-IRON boxes reamed very smoothly in oil, will not "cut" or "gall" nearly as much as one reamed dry. Hence, because this metal is one of the most convenient and cheap, and because it is very durable after it has become glazed and hard on the bearing surface, anything that hastens this condition of a glazed surface is a gain to the arts.

IT seems that there ought to be some means to make dense the surfaces of holes in cast-iron after they are reamed. We would suggest a roller stock small enough to enter the hole freely and long enough to extend through it. About this stock there should be a number of small rollers—at least three—arranged in a groove cut into the stock. A point on the periphery of each of these rollers should crowd into the hole to be smoothed tightly, and be held out against the surface of that hole by the bottom of the groove in the stock. Now, by turning the stock the motion is communicated to the rollers, so that they will slowly roll around the inside of the hole and press its surface smooth and hard. Probably if a rolling reamer such as this were larger by a thousandth part of an inch than the hole it was operated in, it could be forced through and would improve the surface of the hole more than enough to pay for it.

THE best expansion reamer is made thus: Take a shell reamer that is worn below size, anneal it and bore it out, tapered about one-fourth of an inch to the foot, so as to leave the shell not less than one-eighth of an inch thick at any point, and thicker in large sizes. Cut this shell at one point lengthwise nearly through from the outside, but leaving a thin wall. Then harden and grind it inside. Next, fit a suitable shank to its taper-hole, with a nut at each end of the reamer, and force the reamer up the taper shank with one of its nuts until it has broken through the thin wall at the bottom of the slot, and further expand it to a size suitable to be ground and sharpened on the flutes as required. It will be found that this reamer may be expanded evenly so that all the teeth will cut the same, that it may be varied in size considerably, and that the friction on the taper of shank and against the nut will be sufficient to drive it while cutting. Taken altogether, it is a most satisfactory tool.

WHEN "Hamlet" alludes to mechanics' tools in the remark that he knows a "hawk from a handsaw," commentators presume that he means the bird of that name, and they go to great lengths to show that "handsaw" is a misprint. But a hawk is a tool used by plasterers. It is held in the left-hand and takes its name from its resemblance in position to the falcon employed in the ancient sport of hawking. There is no resemblance between a hawk and a handsaw, and the prince of Denmark would indeed have been mad if he had confounded the one with the other.

A HOBBY is a most dangerous thing for a mechanic to ride. Some men, when they find one kind of tool working well, will use it on all things to which it possibly can be applied. Thus, at present, milling-cutters formed on the ends of cylinders are quite the fashion. That such cutters are the best in many cases we freely admit, but that they are the best in all the places where they are used, we certainly deny. It may be that this method is good for cutting machinery, steel and crucible steel, where smooth surfaces to be finished afterward are required, but such results as have come within our observation have been greatly inferior to the peripheral milling. In fact, while the sweeping cut can remove stock most cheaply, it leaves a surface decidedly more rough than that cut by the convex cutter. This may not be so apparent to the touch as it is afterward in the filing or grinding of the surface to a finish. Hence judgment should be exercised in the selection of cutters, and if the surface is to be finished to a polish, preference should be given to the cylindrical cutter. It is true, however, that the sweeping cutter leaves an excellent surface as a foundation to bolt a superstructure upon, being a very true general plane ; in fact, we have something as true as good planing at a fraction of the cost. In such places as this the ridgy character of the milled plane in minute detail assists in holding the superstructure on place on the foundation.

EVERY machinist who reads to inform himself on technical matters is of course an ambitious man who seeks to improve his condition in other ways as well as to cultivate his understanding. For such men there are many opportunities for advancement if they are able to accomplish original and profitable results. Work, not talk, is the means by which all things are accomplished, and ability is but another name for intelligent work. What machinist does not know of a defect in some machine or tool, or does not find that one or another device within his knowledge is not what he believes it could be made? Now when a defect is found or an improvement is believed to be practicable, there is no obstacle in the way of the elimination of that defect or the realization of that improvement that may not be overcome by work. First comes the desire for an improvement, then the effort to satisfy it. In nearly every case there are many ways and means for accomplishing a desired mechanical operation or materializing an advanced idea.

IN machinery—as in all things else—there are no new abstract ideas. Hence, when a thing is to be done, it must be done by using a lever or wheel of some kind, a wedge or screw, a belt or chain, a spring or weight, or some modification or combination of these. So in studying to find a new device, what is to be done is to conceive of all manner of probably efficient levers, wheels, wedges, screws, belts, chains, rods, slides, springs, and weights, and to apply each in turn in the manner most likely to produce the result aimed at. When a device is found that seems to have the elements of success in it, no time should be lost before it is roughly made and tried. This of course is but the beginning of improvement, but when a man has gone so far he will pursue the thing to the end. He will find one element weak and select another. He will do a part of the experiment in drawings and a part in models, and at last he will construct the device perfected, so far as he can see perfection at that time. This is the road upward in our art, and an interesting one it is, though it may be laborious.

THE man who is winning a commercial success may well smile at the schemer. The sole defence he needs is contained in the single word—*results*.

To the Editor:

In your Department of "Machine Shop Practice," for November (page 256), I notice a paragraph relating to a rope-drive which seems to the writer to be working under great disadvantages. In the absence of further information as to exact local conditions, I should think the rope was doing remarkably well "under the circumstances." If the drive is wound continuously, and operated with a traveling slack take-up, as with the Dodge American system, and each floor driven direct from the main driving-sheave, there are too many wheels to insure good results. The life of a rope in such service depends upon the minimum internal friction caused in bending, as well as a liberal proportion between rope and sheave diameters. A rope 1⅛ inches in diameter is much too large for use on a 36-inch sheave, and I cannot understand what complication would necessitate thirty sheaves to reach six floors, one above the other. Better results would be obtained by connecting each floor direct from the main driver, and winding continuously, passing one rope around a slack take-up operating constantly, and so constructed as to permit shrinkage of the ropes without undue strain,—the shrinkage being quite marked where a portion of the ropes run exposed to the weather. The shape of the groove has much to do with the traction qualities and may effect the strain under which the rope is working. Should the drive be wound as in the English system (*i. e.*, each wrap individual and operating independently), the results are good and bad;—good for the English system and bad for rope-driving in general. A loose-spun three-strand rope is the best, but my experience has been that linseed-oil has a tendency to rot the fiber. A better dressing is made of tallow, beeswax, and other ingredients which lubricate as well as form a skin over the exterior of the rope. If the person running the rope-drive mentioned cares to investigate the subject further, I feel confident he will be able to improve the present system and eliminate some of the annoying features now existing which may eventually lead to a serious break-down, and shake his faith in a mode of transmitting power which, if properly installed, is a most satisfactory means of power distribution.

M. W. Mix.

Chicago, Ill., November 7, 1893.

The rope-drive commented on last month was built by a concern whose works are not in the vicinity of New York. The distribution of the sheaves is about as follows: There are nine and an idler on the jack-shaft near the engine. The drive enters the tower at the third floor. This necessitates deflecting sheaves to change the direction of the rope from the horizontal to the vertical, and *vice versa.* Four loops of the rope in the tower go downward and five upwards, and of course each loop drives a sheave. Then there is the tightener-sheave. A closer inspection discovers a larger number of sheaves than was stated originally. Each sheave is polished in the groove and the grooves in all receive the rope in an angle of about sixty degrees. The traction is satisfactory and the loss of power is small. The tallow and beeswax compound did not work well for these reasons: It caused the rope to adhere to the sheaves and wasted a large percentage of the power. It caused the fibers of manila to break so much that the inside of the tower was coated with a dirty gummy coating of the dressing which was filled with short broken manila and its dust. When the rope broke it was all destroyed inside by having its fiber chewed up by friction or flexion. The present dressing of boiled linseed-oil seems to keep the fibers apart and lubricated. They are not rotted, neither do they show any indications of it, being bright and lively. Recently, there being occasion to cut out a piece to reduce the length, the inside was found to be perfect to all appearances. The outside seems to be worn a trifle and made cylindrical by compression. Inside, the oil is quite fluid, while the skin outside the rope polishes very bright soon after the oil-drip is stopped. The only point the writer has cared to make about rope-drives is relative to the value of boiled linseed-oil for a dressing. Facts have been given, and not opinions. We believe that this oil has not been properly tried before, and that when it is so tried it will be found superior to wax, tallow, or other viscid greases. At present the rope on this drive is doing its work very satisfactorily, and if the next six months' performance equals the last, as it promises to do, the experiment will be an economical success as compared with the belting system of driving. The result will be watched with interest.

COMMENT & CRITICISM

The Early Casting of Iron.

THE article on "The Evolution of the Iron-Founder's Art," in the May number of THE ENGINEERING MAGAZINE, in which the credit of originating the art of casting iron was given to one John Thomas, a Welsh boy, about 1709, contains a historical error.

Swank's "History of Iron in All Ages" contains a detailed account of the first iron furnace erected at or near Lynn, in Massachusetts, and of the first casting made there, prior to 1650, which was more than fifty years earlier than the operations of Thomas and Darby. The mold was made by Joseph Jenkes, and the record shows that he cast "a small iron pot holding about one quart," which was *the first iron casting made in the United States or these colonies*. Swank also states that this pot was preserved, and as late as 1844 was still in the possession of the descendants of Thomas Hudson, who owned the land on the Saugus river on which the furnace was built.

It may be true that castings of iron did not come into general use until after 1700, but there must have been some in this country before that, for the colonists, being in great need of iron kettles and other utensils, would hardly have done without them after this demonstration of the possibility of making them here. It is certain we had cast-iron cannon long before the Revolution, and it is to be presumed many other articles also, although the laws of England for the suppression of all manufacturing industries in the colonies may have suppressed that as they did others. The first cast-iron plow in this country was patented to Charles Newbold, of New Jersey, on June 26, 1797.

Jenkes, who came from England, was evidently a very ingenious man, for I find that the General Court of Massachusetts granted him a patent on May 6, 1646, for "the manufacture of engines of mills to go by water,"—probably some form of water-wheel, there being no description of the engine or device. In 1655 the General Court of Massachusetts granted to Jenkes another patent for a scythe, which is said to be the origin of the long scythe such as has since been used so much by farmers. It has been repeatedly stated in print that this was the first patent granted in this country, but that is obviously an error. Not only was his first patent granted five years before, but even before that—June 2, 1641—a patent was granted by the General Court to Samuel Winslow, for ten years, for a method of making salt. This was the first patent granted in this country. The first patent granted under the patent law enacted by Congress April 10, 1790, was one to Samuel Hopkins of Vermont, bearing date July 31, 1790, for the manufacture of pot and pearl ash.

On May 6, 1646, Richard Leader, the general agent of the company, purchased "some of the country's gunnes to melt over at the foundery," which clearly indicates that they had cast-iron guns at that date, though they may have been cast in Europe and brought to the colony. Besides, the privileges granted to the company by the General Court in 1644, and increased in 1645, gave to the company the free use of all materials "for making or molding any manner of gunnes, pots, and all other cast-iron ware," which indicates that it was a known art at that time.

I have been led to make these corrections from the *official records*, because the erroneous statements have been so extensively copied by papers and writers all over the country, and to the end that "the truth of history may be preserved."

W. C. DODGE.

Law and Labor.

In the August number of The Engineering Magazine Mr. R. S. Viktorov, stated on the title page to be a student of the subject, has given a cursory review of "Labor Legislation in England." The tone of the article is unmistakably unfavorable to such legislation; but no other remedy for the growing disabilities of the laboring classes is suggested. Of the two alternative avenues through which labor can seek relief from intolerable burdens,—peaceful law-making or revolutionary violence,—the author of the article under consideration does not indicate which is his choice. He contents himself with simply casting doubt upon the efficacy of the law-making power as a remedy for the real or fancied evils of which labor complains.

From this account of labor legislation in England it appears that non-enforcement of its provisions has been one of the causes of the failure to which Mr. Viktorov directs attention, and this failure to enforce law has largely resulted from impracticable features of the laws. But this sort of failure is not confined to labor legislation. It is equally pronounced in sanitary legislation, legislation for prevention of smuggling, laws for regulating sale of liquors and food, Sunday laws, etc. If more or less failure to enforce laws relating to any social condition which it may be desirable to promote or to suppress be a sufficient reason for abandoning legislation in such direction, what other resources are at command in dealing with prevalent and growing evils? Obviously either society must be abandoned to anarchy, or attempts, often unsuccessful but sometimes otherwise, must continue to be made through legislation to remedy evils that arise as civilization advances, and which spring from new inventions, new discoveries, and changes in habits of living, just as naturally as benefits. The cheap illumination furnished by petroleum oil has been accompanied by increased fire risk resulting from its general use as an illuminant. Certain dangers to life and limb now exist that were unknown prior to the adoption of electric propulsion for street railways. Not to multiply illustrations, this same sisterhood of good and evil may be found in any close scrutiny of the results of any important improvement.

What then! Must the benefits of all improvements be renounced because they also entail some evils? Should we not rather accept the benefit and strive by peaceful and orderly means to suppress, or, if this be impracticable, to regulate and minimize, the attendant evil?

Nothing is surer than that in legislation and social order the law of the survival of the fittest holds with as much force as in the development of species in the animal and vegetable kingdoms. To fail once, thrice, or even many times is often necessary to ultimate progress (social and economic science not excepted), for lessons of temporary failure are often not less valuable as pointing the way to truth than those of temporary success. If legislation be hopeless as a remedy for social evils, there is little hope for the future of civilization, and a strong probability that anarchical principles will bring about a revival of barbarism, out of which wreck it may require ages to again evolve a new civilization.

A. Bardolf.

The · World's · · Fair · in · Retrospect ·

A SOUVENIR NUMBER OF

THE ENGINEERING MAGAZINE

SPECIALLY DESIGNED TO INDICATE THE PRACTICAL VALUE OF THE WORLD'S COLUMBIAN EXPOSITION TO THE SCIENCE AND INDUSTRY OF THE TIME

A BIRD'S EYE VIEW OF THE FAIR.

A VIEW OF THE FAIR FROM THE MIDWAY PLAISANCE.

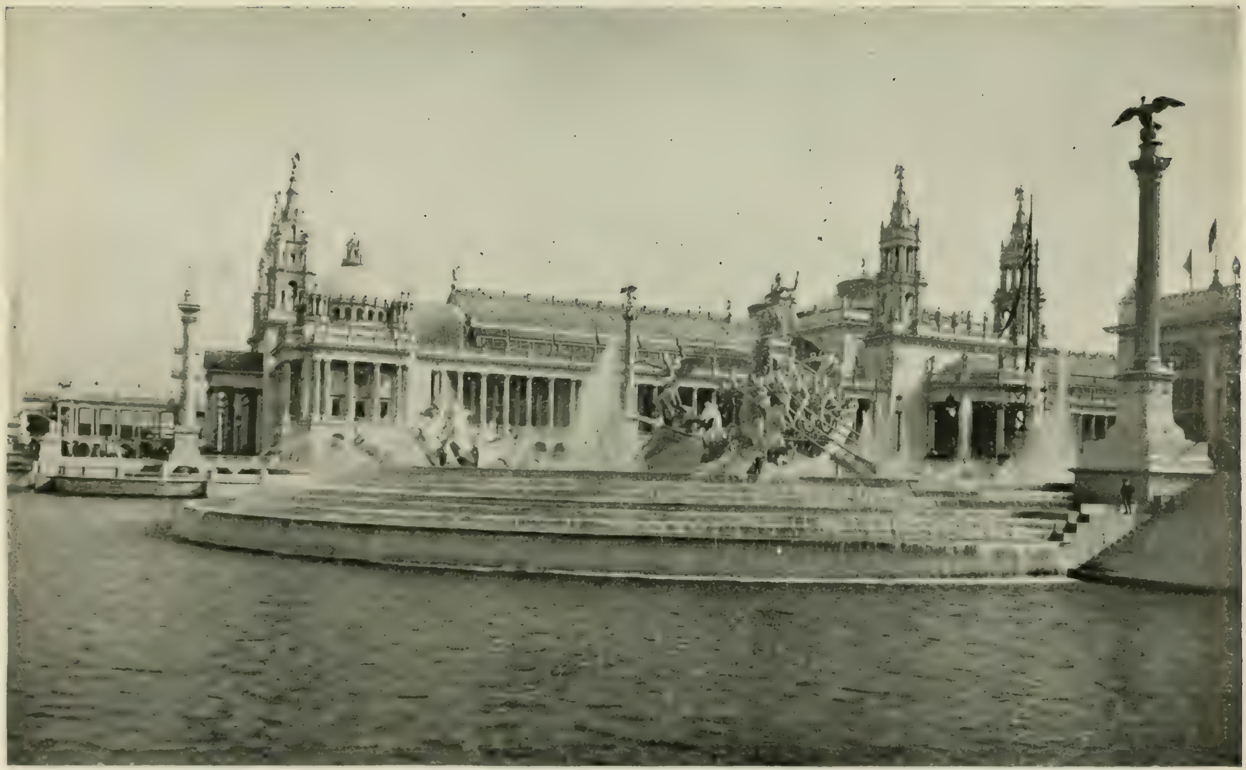
THE ADMINISTRATION BUILDING.

THE COURT OF HONOR, FROM THE ADMINISTRATION BUILDING.

THE COURT OF HONOR, FROM THE PERISTYLE.

THE PERISTYLE AND THE STATUE OF "THE REPUBLIC."

THE COURT OF HONOR LOOKING FROM THE SOUTH.



THE MACMONNIES FOUNTAIN.

MANUFACTURES AND LIBERAL ARTS BUILDING.

INTERIOR VIEW OF THE LIBERAL ARTS BUILDING.

THE ELECTRICITY BUILDING.

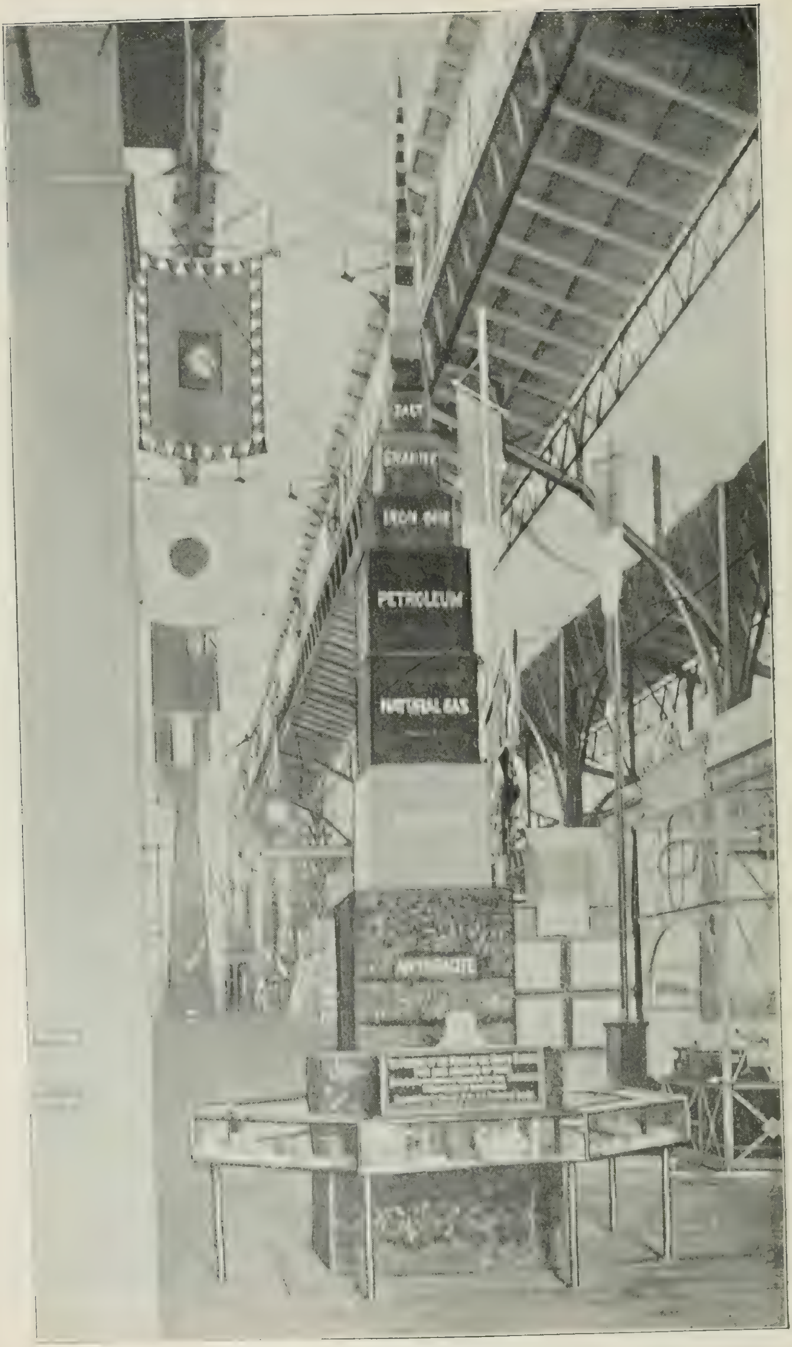
THE PALACE OF MECHANIC ARTS.

THE AGRICULTURAL BUILDING.

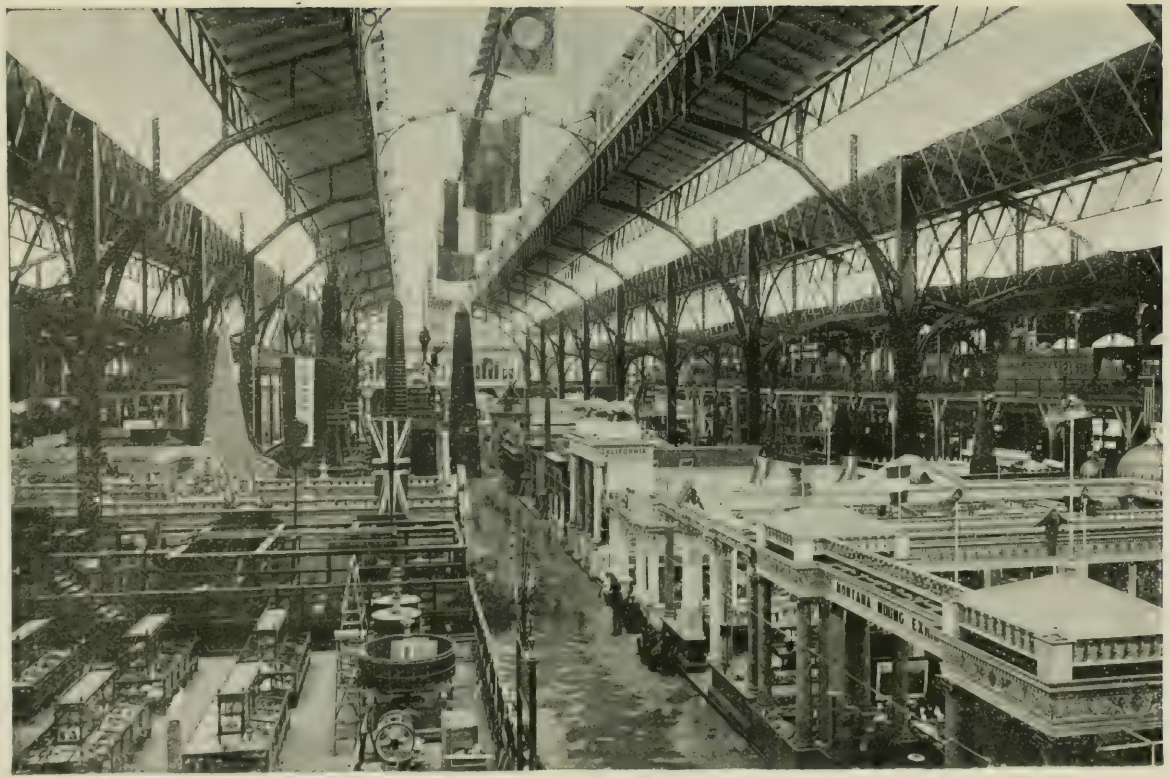
A VIEW IN THE AGRICULTURAL BUILDING.

THE MINING BUILDING.

NEW SOUTH WALES EXHIBIT IN THE MINING BUILDING.



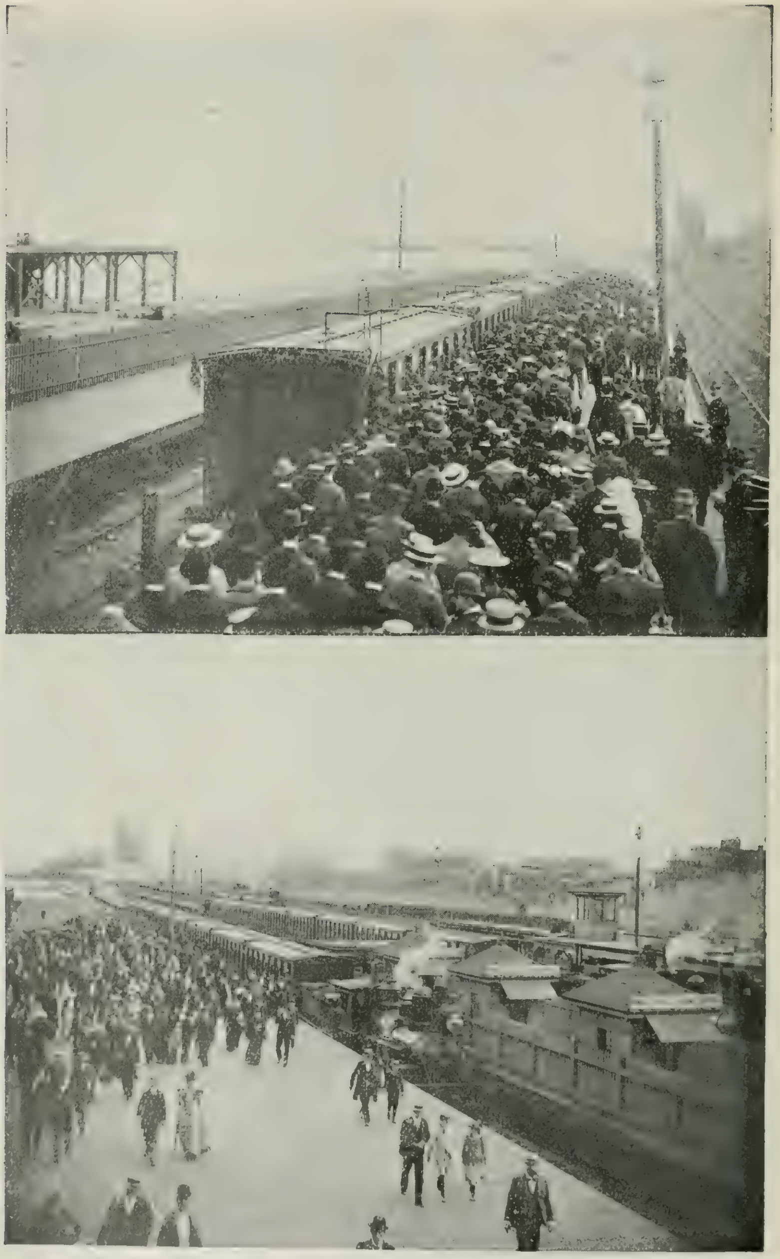
COLUMN ILLUSTRATING MINERAL PRODUCTION.



A VIEW IN THE MINING BUILDING.

THE MONTANA EXHIBIT IN THE MINING BUILDING.

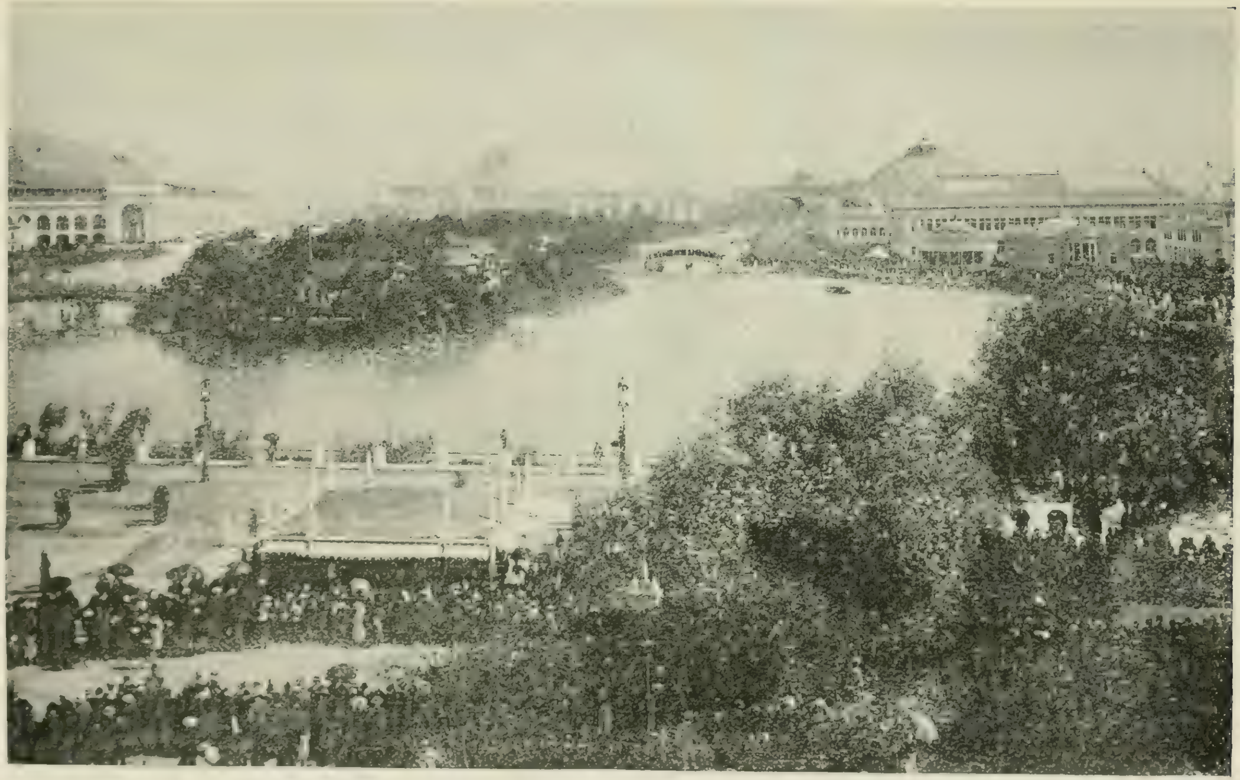
THE TERMINAL STATION.



LOADING AND UNLOADING ILLINOIS CENTRAL TRAINS AT THE FAIR.

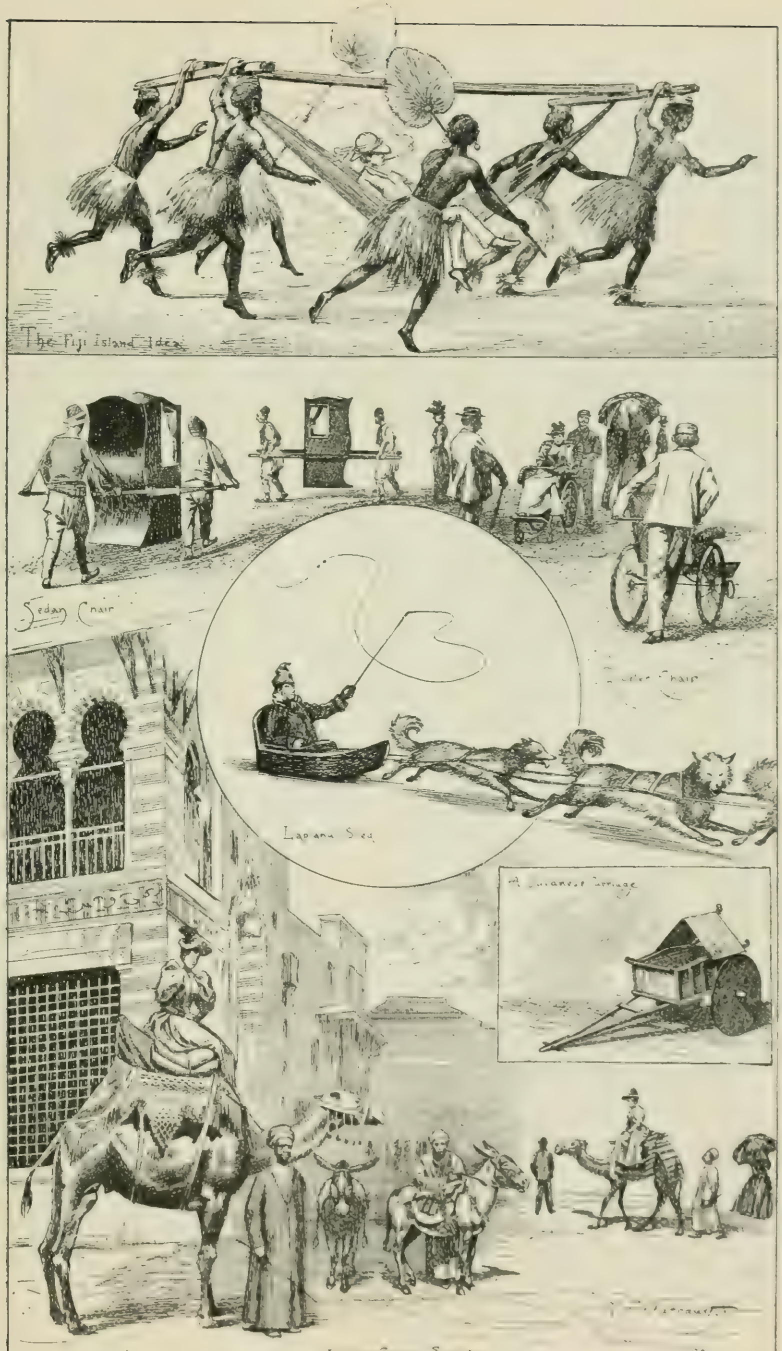
THE TRANSPORTATION BUILDING.

A VIEW IN THE TRANSPORTATION BUILDING.



THE WOODED ISLAND.

THE FINE ARTS BUILDING.



SOME TRANSPORTATION EXHIBITS.

THE HORTICULTURAL BUILDING.

THE FISHERIES BUILDING.

A VIEW IN THE FISHERIES BUILDING.

A GALLERY IN THE FINE ARTS BUILDING.

UNITED STATES GOVERNMENT BUILDING.

THE

ENGINEERING MAGAZINE

VOL. VI. JANUARY, 1894. No. 4.

VALUE OF THE WORLD'S FAIR TO THE AMERICAN PEOPLE.

By Andrew Carnegie.

THE great exhibition has come, triumphed, and passed away. The unrivalled mass of beautiful structures which seemed rather to have dropped from above than to have been slowly built up from below, are being rapidly dismantled. Our revels are ended. Prospero's wand has broken the spell. The cloud-capped towers, the gorgeous palaces, have dissolved ; but the impression made by these greater than Aladdin's palaces remains, even more vivid than when received. Every one who was privileged to spend days and evenings in windings in and out, through and among the palaces of the White City, and especially to saunter there at night when footsteps were few, has the knowledge to treasure up that he has seen and felt the influence of the greatest combination of architectural beauty which man has ever created.

The universal verdict is that no previous exhibition had ever scored such a triumph. Equally universal is the gratification that it was held in Chicago. When it was decided that the discovery of the country by Columbus should be celebrated, it seemed to be taken for granted at first that there was but one proper place for the ceremony. Soon, however, a second claimant intimated its advantages, but the East was slow to realize that there was anything to be said for the western city. The people of the eastern Atlantic States travel far too little westward. The mention of Chicago as a possible site generally created a smile on the face of the citizens of New York. There were a few, however, from the very first who saw that irrespective of the merits of the two cities it was due to the great West that the forthcoming exhibition should be held there. These fair minded people argued that the East had had its celebration in Philadelphia. The revolution in the taste of the people which that display effected was surprising, and the West, it was felt, should have an opportunity to profit through the same means. To day not only do the citizens of New York agree that in every way it was best that the choice fell as it did upon Chicago, but a vast majority go much further and admit that it would have been impossible for New York to equal the success achieved had the exhibition been held there, or indeed anywhere save in the western metropolis,—the center and headquarters of Triumphant Democracy. All honor then to Chicago. Her action throughout entitles her to rank as the most public-spirited city in the world. There are other proofs of her claim to this proud preëminence in the magnificent sums which her citizens vie one with another in providing for the highest wants of a population soon to be numbered by millions. Fourteen millions of dollars given or bequeathed by her citizens are to-day being spent for the good of the city, in patriotic pride of which every Chicago citizen seems to share. Amid much for which this very modern community serves as a model to others let the possession of a salutary civic pride be carefully noted and credited.

The exhibition is closed. What then have been its lessons and its value to the Republic? Others are to give the readers of The Engineering Magazine in detail their replies to this inquiry. Each writer selected for this work is a foremost authority in the branch he is to consider. So eminently qualified are these men for the task that one finds himself looking forward with pleasurable anticipation for their respective contributions to the Magazine. Happily the modest part assigned the writer by the editor is only to give his impressions of the result as a whole, which requires no special knowledge.

First, then, the grandest thing about the exhibition was the scene from without. The frame was finer than the picture, and more valuable. The temple viewed from afar was more precious than the temple viewed from within. This is high praise. The first impression of the Taj seen from the garden renders minute inspection of the interior common-place in the extreme. The sight of the Parthenon taught the Greeks more of the beauty in art than anything which it contained. The sight of Edinburgh castle, says Ruskin, influences every Scotch boy who has soul enough to be influenced, and so the dazzling glimpse of that exquisite scene in Jackson Park, the first to greet the eye of the beholder, will be the last to fade from his recollection. I make bold to say that after every work of art, every ponderous engine, every invention, everything that proved the cunning brain and hand of man, has faded away, the general effect of the purely artistic triumph attained by the buildings and their environment will remain, vividly defined in the memory and recorded there unmixed with baser matter. The best reason for heartfelt gratitude and pride is that the notable success of the Chicago exhibition was not material. That our electric display dwarfed what all nations of the earth combined could produce ; that our transportation department was a revelation ; that the heap of silver, lead, coal, and iron-stone was prodigious ; that there were temples made of corn, and highly artistic effects produced from cereals,—all this was much from one point of view. But from the standpoint of the status of the Republic as a civilized nation, a candidate for supremacy among the nations in the region of art and civilization, these material triumphs pass as a matter of course. We were expected to excel, in these. The grand point is, that incontestable as was our success in these material things, it was yet not so strangely or so unexpectedly incontestable as our triumph in the higher realm of artistic development. "Sir," said an eminent Frenchman, "these buildings at Chicago seem as if they must have been produced by us in Paris, and those that we boasted of in Paris seem now as if they must have been designed and erected in Chicago."

There are three points upon which the success in art was surprising. One I have indicated—architecture : the design and grouping of the buildings themselves, especially in connection with the utilization of the water, which made the scene unique. In sculpture some very notable works appeared. The chief successes in statuary were, of course, in the groups upon and around the buildings, but the work exhibited within was in some instances very remarkable. The American school of sculpture has established itself through this exhibition.

In another department of art the surprise was even more complete. I refer to the American school of painting. There has never been brought together before such an array of the best paintings of American artists. It must, of course, be remembered that the foreign pictures were not of the best, while the American were of the very best ; but even keeping this in mind, the result of careful and repeated examinations made by many experts was that even with the best of the foreign modern masters the best of the American modern pictures would hold their place. One American collector was able to exhibit so great a number of the gems of the collection that I could not help envying his position. I did not know any one connected with the entire exhibition who can more truly be considered a public benefactor than this artistic gentleman, who has evidently for many years had faith in the genius of his countrymen, and has quietly purchased the best examples of their work as these came forth.

Many congresses assembled in Chicago upon the invitation of the exhibition authorities. Only one of these, I think, is destined in the future to affect the stream of tendency to any great extent. This is not said to disparage any other assembly, because every little aid to a good cause helps. But the Parliament of Religions was an original idea. Never before have the representatives of the various and different religious beliefs appeared upon a common platform upon terms of perfect equality to explain and support their respective forms of belief. That the idea of such a commingling arose, is a cheering sign of the progress the race has made, for within the lifetime of many still living it would have been scouted as almost blasphemous. It is not so very long ago that we western people modestly assumed that we alone had the truth, the whole truth, and nothing but the truth, and that the Unknown had kindly favored us to the exclusion of the vast majority of his creatures. To-day, it seems that the various sects of Christianity are ready to believe that an all-merciful creator feeds his people, whom he has created in the various lands of the world, with the food which he thinks they are severally best adapted to receive and assimilate for their good. It was a notable sight to see the devout worshipper of the East explain to his rather egotistical brother of the West that the heathens have not been left without heavenly guidance. I wondered that some of our own people did not quote Matthew Arnold's appropriate lines to prove that the Christian poet was not less advanced than these heathens in the view which they take of the wisdom and care which the Father of all takes of all his children. Christian and pagan could have united in reciting these lines:

> "Children of men! the unseen Power whose eye
> Forever doth accompany mankind,
> Hath look'd on no religion scornfully
> That men did ever find.

Which has not taught weak will how much they can?
Which has not fall'n on the dry heart like rain?
Which has not cried to sunk, self-weary man,
Thou must be born again."

The Parliament of Religions may be credited with having set in motion many forces tending to the harmonizing, and ultimately to the unifying, of the principal forms of religious belief. At all events, it seems to render the differences between the various sects of Christianity much smaller than they were before.

The favored traveler who had done the sights of the world was disposed to jeer at the Midway Plaisance, but I doubt if any department of the exhibition gave as much pleasure and even instruction to as great a number as this unique feature did to the vast majority who cannot hope to travel abroad. The Javanese village, the street in Cairo, the German village, and even the sight of the reproduction of Blarney castle and many other national scenes were object lessons which gave the best possible substitute for personal inspection of the original. The longing of the American to visit the older countries of Europe is as general as it is strong, but only about 30,000 out of 65,000,000 people go abroad yearly and fully one-half of these have been before, so that not more than 15,000 fresh visitors go each year. Consequently only a very trifling percentage of the whole mass can ever see with their own eyes the scenes about which they read so constantly. None of the arrangements of the managers of the Chicago exhibition seem to have been wiser than the bringing over of correct representations of the lives and homes of the various peoples of Europe and Asia.

From a national point of view, the chief good from such an exhibition as we are just now considering arises from the gathering together of the people of the different sections. The few who travel much fail to remember that the masses of the people travel but little. Their reunions are confined to the immediate neighborhood. At the most, a State fair draws them together from the same State; but at Chicago the citizens of different States, with their families, were brought into close and intimate relation. Every citizen became not only prouder than ever of his country, of whose position and greatness the exhibition was the outward and visible symbol, but he became acquainted for the first time, perhaps, with his fellow countrymen of other States.

The impression made by the people *en masse* was highly complimentary to the American. I never heard a foreigner give his impression who failed to extol the remarkable behavior of the crowd, its good manners, temperance, kindliness, and the total absence of rude selfish pushing for advantage which is usual in corresponding gatherings abroad. The self-governing capacity of the people shone forth resplendently. The foreigner's verdict is that without official direction or supervision every individual governed himself and behaved like a gentleman. So much for universal education.

In a federation so extensive as ours this drawing together of the people of the States is a work of great difficulty, and yet it is of infinite importance, for the masses of the people should not grow up without having in their midst living links who have met their fellow-citizens from other States and found them much like themselves, and in harmony upon one point at least,—their intense Americanism. Every plan should therefore be encouraged which draws the people of the different States together, and an exhibition like that just held at Chicago is by far the most efficacious of all modes. The seventeen years that passed between the Philadelphia exhibition and that at Chicago was a period quite long enough. At least once every twenty years the people should be induced to gather from all the States as they did at Chicago, and, if possible, each section of the Union should be favored by having this national reunion—East and West, North, South, and Center.

Meanwhile let every citizen for himself, and every State for itself, and the Union for the nation as a whole, cherish a deep sense of the invaluable service rendered to the Republic by the people of Chicago, our "Western metropolis," of which no American can hereafter fail to be proud. It undertook a great task, encountered unexpected difficulties, surmounted all obstacles, and ended by giving the world its most notable exhibition.

EFFECTS OF THE CENTENNIAL EXHIBITION.

By Alfred T. Goshorn,

Director-General of the Centennial Exhibition, 1876.

THE World's Columbian Exposition has passed into history, and has taken its place beside the other great exhibitions. Its active presence is gone, but a host of impulses, founded upon impressions received there, remain as a vital heritage of the World's Fair. The amusements, the spectacular attractions of the moment, all these diversions have passed away. In their place we shall now find showing themselves from time to time whatever permanent impressions were there received by our people. Some of these are already patent, particularly those of an esthetic nature which originated in the architectural and sculptural beauty of the grounds. Many of the other impressions are not now to be discerned, much less measured. They have in large part not yet crystalized into impulses bearing actively upon our national culture and industrial welfare. In due time, however, we shall be able to trace this or that to the Chicago exhibition, as we do similar lines of development back to the Centennial Exhibition in Philadelphia. Many of us may have suspected in the winter of 1876 that our arts and industries had in the preceding summer received a profound shaking-up, but no one could then know how powerful and all-pervading the stimulus was destined to be. It seems all so clear now, that we find difficulty in recalling the conditions which prevailed here prior to 1876. We have become so accustomed to the state that has resulted from nearly twenty years of progress upon lines then laid down, that a clear retrospect is almost impossible. There may be changes as great, innovations as surprising, already started by the Columbian Exposition, and we may be as little cognizant of their real meaning as in 1876 we were of those following the Centennial. International exhibitions are among the most effective of national educators. They tend to raise each of the coöperating nations to the level of the highest in artistic, industrial, and scientific advancement, and they stimulate that one to still more energetic efforts to preserve supremacy.

The Centennial Exhibition found the American people engrossed in the development of the natural resources of a country whose riches still remain unmeasured. Art, literature, and esthetic culture, of which some real appreciation existed in the rather settled civilization of the Atlantic States during later colonial times and the earlier portion of this century, could, toward the middle of the century, offer to young men but weak inducements compared with the dreams of wealth to be realized in the fabulous West. From Maine to California the country became one vast field in which material prosperity was the idol. The civil war strained every sinew. When it was over this exceptional energy was released in the old materialistic channels. We ran along to the panic of 1873. Recovering somewhat from that by 1876, we were in a condition most favorable to the reception of new impulses. The inflation of war-times, and the speculative activity of the ensuing years had given way to a more conservative spirit. We became ready to believe that culture and taste might be of greater value in life, and that pure material prosperity might be less fit to absorb our entire interest. Accumulated wealth provided the means of gratifying tastes thus created. Accordingly, when the Centennial Exhibition was opened, the American people—particularly those of the eastern seaboard—were, more than they realized, ready and eager to enjoy the many products of industrial art that were sent to Philadelphia from Europe and the Orient.

The fundamental principle of the Centennial, that to which the organization and the administration invariably sought to conform, was a desire to place before our people the products of the world, particularly those of the art industries, in such order that powerful educational influences might be brought to bear upon our country. The Exhibition was planned for the exhibits, for which it was the framework, the setting, or the background. With this in mind, spectacular attractiveness was made secondary. Nothing was tolerated that could detract from the instructive force of the articles placed on exhibition. We felt that the exhibits were of such supreme interest that nothing else need be resorted to to draw the people. There was in these quite enough to occupy the exclusive attention of visitors. The lessons to be learned from these manufactures were of such importance, as bearing upon our advancement at that time, that it seemed wise to give little thought to other things. The effectiveness of the Centennial as an educator is no doubt largely due to the concentration upon this one fundamental aim,—to this simplicity of purpose.

The classification of exhibits, the installation, the system of awards, were all based upon the educational influence of the objects shown. The judges were experts, and their reports were statements of the excellence possessed by the articles upon which they recommended awards. The published reports of the jurors are records of this or that merit in objects compared with one another. The award of uniform value was accompanied by an expression of opinion that in few words went to the heart of each case. It is safe to say that by general consent the Centennial Exhibition was unusually successful among exhibitions in its efforts to systematically educate its visitors. The impulses that went out from it to all the industries, all the arts, in science, and in general culture, gave new vitality to American civilization. Its work was well done, not only because it was wisely planned and guided, but because the people were ready to receive understandingly the lessons it presented, and because those seem to have been the lessons we actually most needed at that stage of progress.

It is not necessary to review in detail the advancement made in science, art, and the industries in the years from 1876 to May, 1893, when the Columbian Exposition began to exert influence.

It is sufficient in a general way to indicate the tremendous movement in the direction of esthetic culture that has raised us from a people absorbed in the pursuit of material prosperity, of utilitarianism, to a condition in which we have more than begun to appreciate the higher refinement that art brings to our lives, individually and as a people. In 1875 many objects we prized for utility were ugly, and we did not know it. Now, we demand that the articles, of whatever kind, shall be appropriate not in utilitarian construction alone, but shall also be in keeping with that "eternal fitness" which is perhaps the closest definition one can give of taste. We learned in Philadelphia a great deal about the natural resources of our continent, and much that led to the scientific development of industries, but we learned also that we had overlooked taste.

The Centennial, naturally, made radical changes in our foreign trade. Many foreign manufactures, until then unknown to us, soon became regular articles of commerce, and the artistic merit of the importations improved from year to year with the growing demand. It is difficult to realize now the rapidity and volume of this influx, and the changes in taste resulting from it. Every application of art was embraced in it, until now the United States has become one of the great markets for the products of the world's art industries. We are so familiar with these articles in the shops of our cities that it seems impossible that until the Centennial Exhibition they were almost entirely unknown to us. Importers familiar with European markets say that to-day American women are more exacting, more critical, than the same class of buyers abroad. I do not refer so much to the very expensive objects of art, bought by collectors, as to the articles of regular use, such as table ware, decorated pottery, and porcelain, glass and silverware, for example. Of careful collectors of the finer works of art we have also our share,—a hundred now where there was one in 1875. I do not mean only those collectors whose means enable them to buy where and whenever they find, but rather those who have that characteristic faculty of ransacking and saving from loss, or destruction, the many valuable objects of which the purchase price is not the first evidence of worth.

Out of this has grown a series of museums large and small, in which private enterprise has undertaken the educational work in the arts, the industries, and in natural science, which, in Europe, is carried on with the aid of public funds. The growth of the collections in these museums since 1876 is astounding. Those who founded and who have administered them have succeeded beyond expectation in accumulating instructive specimens of all sorts. Consequently, these institutions have in a few years become powerful educational centers, expanding farther and farther the impulses which started in Philadelphia. A number of these museums bear a more creditable comparison with some of the older museums of Europe than one would at all expect when recalling the few years of their existence. For instance, the achievements of the ancient world and those of the Renaissance,—in sculpture, painting, and the applied arts,—which were unknown to us as a people twenty years ago, are now intelligently studied in collections of casts and similar reproductions, and in not a few originals.

Alongside of these museums have sprung up in even greater numbers art schools and technical schools. There is hardly a city of any size that has not one or more of these schools, studiously training each year its hundreds of young men in art and science. This striving for skill in artistic and technical expression is but one branch of the great fundamental movement we are considering. Art schools in New York, Cincinnati, Boston, St. Louis, Philadelphia, and Chicago present opportunities for the development of ability to draw, paint and model, and design, already adequate to carry the pupils to the point where they may become self-reliant students able to direct their own further training, and prepared to apply to their own uses the lessons of past and present achievements in Europe.

Nor did the Centennial affect art education alone. The impetus extended as well to general education. It could not do otherwise, for the very foundations of our civilization were affected. Before 1876 we were a provincial people. However able, however intelligent we may have been, our ideas and sympathies were local, not cosmopolitan. There was a prevailing contempt for the foreigner and his slow, old-fashioned ways. We prided ourselves that America was American, and felt irritated by the foreigner's criticism, often expressed, that we were provincial. The Centennial Exhibition removed much of this spirit, and marked the introduction of business and social relations with foreigners, out of which has grown from year to year a greater respect for the culture which European life has attained after centuries of experience. What we lacked of that culture we have set ourselves to acquire. The manly recognition of one-sided development, and the determination to broaden ourselves, is characteristically American, and has gained for us the respect of the world of culture. Of course, university and college life has been influenced by this change of standpoint, and these institutions have sought to respond to the demand. To assure one's self, compare the Harvard, Yale, or Princeton of to-day with that of 1875.

A reflex movement occurred in the rest of the world, especially in Europe, which found itself brought by the knowledge of 1876 into a different relation to the United States. The Philadelphia exhibition was an opportunity to show foreigners the sources and accomplishments of our country in a way they had not previously seen them. Our exhibits were a revelation to Europeans, as theirs were to us. The social and commercial relations thus naturally established, and the ties connecting our large population of immigrants with Europe, have carried into Europe many American ideas, social, political, and commercial. In this exchange our gain s by far the greater, for the old word is sluggish and less responsive.

So much has recently been said in reference to the development of domestic manufactures that I need write little more here. Not only has there been a marked progress in all those industries in which art is applied, but it has extended to others as well. Machinery, of which our exhibit in Philadelphia was strong, has advanced upon some lines that were suggested by foreign exhibits at that time. Its construction has become more scientific, its uses have been better directed, as our knowledge of methods grew. More exact calculation, and less inventional inspiration, enters into it now. In other directions likewise knowledge of European methods has placed our industries upon a more intelligent footing. Consequently, we are more and more able to compete in foreign markets, and our foreign trade is destined to change largely from cereals and food products to manufactures.

This close association with Europe has had important consequences upon our business methods. The direct and constant exchange of business between New York, London, Paris, and Berlin has made our methods more exact, more regular, and has resulted in an organization of business marvelously effective in production, manufactures, and distribution. No enterprise is now so great that capital cannot be provided for its execution.

These are some of the direct and indirect effects of the Centennial Exhibition, which in some instances actually created movements, and to others already existing gave a vitality tenfold greater. As I have said, this impression was made upon the very root of our national and social life. The years since 1876 seem, indeed, to form part of a period of reconstruction such as rarely occurs in the life of a people. This progress paved the way for the great exhibition that has just closed in Chicago, and which may be said to mark our national attainment along the lines of the impulses of the Centennial. The architectural features of Jackson Park were impossible of execution in 1876. Nor could they have been understood and appreciated at that time. The problem of buildings in Philadelphia was to house exhibits, and not to attempt an architectural display. We abandoned the intention of carrying out a scheme of elaborate architecture, partly because of the expense, but principally because it did not occur to us that anything could or should be made of more importance than the exhibits themselves. Accordingly, our buildings and grounds were simple, dignified, and appropriate to the uses to which the place was to be put as a receptacle for exhibits. They were attractive, and in an unostentatious way beautiful, but one felt that they were of secondary importance in comparison with what was to be seen in them. The result was that the visitors did study the exhibits, looked at them closely and intelligently, and were amazed at what the old world disclosed before their eyes. It was the lesson that time has shown we then needed,—and the fact that the Centennial taught it was its justification.

The problem which the promoters of the exhibition in Chicago this year had to face was a different one,—different by reason of the intervening progress. More was demanded by the esthetic culture of to-day. Art was felt to have been the spark that had vitalized American life in 1876, and to art again Chicago looked. The local directory turned not to the minor industrial arts, but directly to the great art of architecture, and they determined that so far as lay within their power, the exhibition of 1893 should show to the American people an architectural spectacle that should stand foremost among the artistic achievements of modern culture; that the American people should see what the accumulated art of centuries means; and that the world should see the mark to which American civilization aspires and has in part attained. The connection of this with the Centennial I hope to have made partially clear. Of the future little can safely be predicted. We know what the Centennial did. We know how profound an impression the buildings in Chicago have made. We can but look forward with confident expectation that the impulse of 1893 will be similar in character and in vigor to that of 1876.

THE ARCHITECTURAL EVENT OF OUR TIMES.

By Henry Van Brunt.

THE greater buildings of the World's Columbian Exposition were created primarily to accommodate most worthily a vast international display of works of industry and art. They not only fulfilled this purpose, but they expressed in terms of architecture the highest civilization of our times. It is evident that this result was attained, because no other architectural demonstration in history has received such cordial recognition by the people as an intelligible exposition of fine art or enjoyed such a universal tribute of respect and admiration. If it had been of a nature to be appreciated only by critics, and had been received by the people with indifference, it would have been merely exotic, and in no sense representative of the modern spirit in its best estate.

The study of architecture in modern times has all the elements to be derived from a liberal education; for the study not only embraces the acquisition of a scientific and artistic technique, but, as its scope must necessarily cover an exhaustive survey of all the achievements of the past in this art, and their close connection with the development of nations and the genius of races, it must be, to all who pursue it seriously, an enlargement, a strengthening, and a refinement of the mind. The opportunity presented at Jackson Park for a manifestation of the results of this liberal education in the greatest of the fine arts was unprecedented; it was practically unrestrained by the usual cramping conditions of practice in architecture. There was no whim or prejudice of a client to be ingeniously accommodated, and no restrictions of economy or commercial convenience to be reconciled to art. On the contrary, from the beginning, the architects who were fortunate enough to be called to this great work were encouraged by the large, intelligent, and generous sympathy of the local board of directors, and by the superb public spirit of the citizens of Chicago. But this sympathy and this public spirit might easily have furnished a dangerous initial force, if it had not been made effective in the interests of highest art and brought home to the architects by the professional enthusiasm, by the noble and disinterested zeal of their brother, Mr. D. H. Burnham of Chicago,—without whose phenomenal organizing power, breadth of view, and personal force, as director of works and chief of construction, it is not too much to say, the architecture of the Exposition of 1893 would have been impossible. Indeed, in this one instance at least the art was left to its own inspirations. The results of these unprecedented conditions have been justified by their effect upon minds hitherto inaccessible to appeals of art.

If the conscientious study of this art is, as I have said, a liberal education to the architect, this great demonstration had, to an appreciable extent, a similar effect upon the public. Much of its carefully-studied detail was lost to the masses, of course ; but there was some general quality in it which moved all minds to unwonted emotions and aroused a sort of pleasure and exaltation of sentiment which they had derived from no other experience of life. To millions of intelligences, from the highest to the lowest, the architecture of Jackson Park, with its subsidiary sculpture and painting, was a revelation of the power of art, and millions of lives were made larger and fuller by the experience. It has been often questioned whether architecture has not in modern times ceased to interest the people as it did in the great eras of the past. They have for the most part been indifferent to its most monumental manifestations because they have not understood them. The Exposition of 1893 apparently restored this art to the people, and rehabilitated it as one of the acknowledged agencies of civilization. Indeed, it has perhaps restored architecture to architects, in giving to them a memorable object-lesson of the immense impressiveness of loyalty to those established types of art which were connected with and expressive of the greatest eras of human history, and of the importance of subjecting the inventive powers of design to the chastisement and discipline of serious study.

The most valuable retrospect of the architecture of the Columbian Exposition, therefore, is to be obtained far less from a technical description, which might not be understood, or from a general description, which could not describe, than from a brief analysis of the special architectural conditions which awakened an interest so genuine and so general. The architects of the great buildings concerned themselves only to create once for all pure architecture according to the highest standards—an architecture which should be its own excuse for existence. They did not aim to astonish or to amuse, and in fact hardly expected to be appreciated save by a few, who, by training and special culture, had established intelligent and intelligible ideals of art. They had been so accustomed to public indifference that the consensus of interest which was presently aroused by their work had all the force of a surprise to them. They found, for the first time in their experience, that at least the broadest effects of art which they had aimed to establish had at last found entrance into the minds and hearts of the multitude with a new enlightenment. They hoped for the usual award of an approving artistic conscience; they enjoyed also the unexpected award of popular approval. Their architectural epic, though expressed in a learned tongue, in a language of complicated historical conventions, was not entirely unintelligible even to the untrained mind. This is at once an encouragement and an incentive to the practice of pure art.

The secret of this tardy but most effective awakening of the public mind to the consciousness of architecture as a fine art is easily revealed. In the first place, the great creation at Jackson Park was made intelligible to the people by its harmonious unity. But if this unity had been mere uniformity, though it would still have surprised them by reason of its magnitude, it would have left no durable impression of pleasure or profit, because its monotony would have fatigued the eye, and its want of imagination would have left the higher emotions untouched. If one side of the great formal court of ceremony had exactly reflected the opposite side, no one but a precisionist, or a drill-sergeant, or a mathematician would have taken any delight in it. It is clear therefore that, in the second place, another quality besides unity,—namely diversity,—was an essential part of the architectural scheme. But to make diversity consistent with unity,—or, in terms more familiar to the critic, to obtain variety in unity,—is perhaps the most difficult problem in architectural composition; indeed it is a problem which, on a large scale, can hardly be solved by any single mind without affectations of contrast which, by their obvious artificiality, their conscious pose, defeat the great object to be obtained by this rare reconciliation of opposing qualities. The great architects of the Renaissance, especially after the beginning of the seventeenth century, generally aimed at exact correspondences in their larger and more important compositions, as in civic squares and in the courtyards of palaces; but they never succeeded in producing results as interesting and poetic as those almost unconsciously achieved by the first Renaissance builders in the sixteenth century, who, fresh from the old Gothic or Romantic freedom of habit in design, would not suffer themselves to be constrained by the rigidities of a classic formula, as all their successors were. Consequently, in the third place, a coöperation of distinct and sympathetic individualities, trained alike in the theory and practice of architecture, was necessary, so that each, being restrained by the adoption of certain leading conditions of composition, common to all the buildings, could more or less unconsciously differentiate his work from the rest by the operation of the personal equation. This differentiation, being the result of natural differences in temperament, mood, and experience, secured the necessary quality of unaffected variety, without offense to the quality of unity, which, in its turn, was preserved by subjecting the leading ideas to each design to a general architectural scheme.

Confining ourselves for the present to the consideration of the Court of Honor, a coöperation of the most sincere and fruitful character was obtained and a national character given to the enterprise by the judicious and generous selection of five architects outside of Chicago, who by reason of extensive practice and wide observation had proved themselves capable of undertaking serious and difficult work of this sort and of comprehending the fundamental importance of discipline in any collaboration of art. The architects so chosen and the buildings assigned to each were as follows: Richard M. Hunt (New York), the Administration building; Peabody & Stearns (Boston), the Machinery building; McKim, Mead & White (New York), the Agricultural building; George B. Post (New York), the Manufactures building; Van Brunt & Howe (Kansas City), the Electricity building.

To this list was afterwards added Charles B. Atwood, chief of the department of design in the office of the director of works, who designed the Peristyle, which separated the east side of the Court from the Lake by an open architectural screen, and the Terminal building, which enclosed the Court on the westward or landward side. The subsequent enlargement of the Court toward the west finally included the Mines building, so that its architect, S. S. Beman of Chicago, became practically a member of this especial division of the architectural board. Adler & Sullivan, architects of the Transportation building; Jenney & Mundie of the Horticultural building; Burling & Whitehouse, of the Festival Hall; and Henry Ives Cobb, of the Fisheries building, all of Chicago, were also members of the board; but their work, being outside the Court of Honor, and placed in that part of the park where the internal water-system had been released from the artificial restrictions of the formal canals and suffered to expatiate capriciously in the broad lagoon, was, in sympathy with the changed topographical conditions, invited to assume a free and more romantic character. The architects of the Transportation and Fisheries buildings frankly availed themselves of this opportunity and, in a manner entirely American, showed that they could be unconventional without license, archæological without pedantry, and independent without caprice.

The members of the general architectural board met for the first time in Chicago on January 10, 1891, and the final general tentative plan of the grounds with the proposed locations of the greater buildings, which had been in course of preparation for several months by the firm of Frederick Law Olmsted & Co., landscape architects, of Brookline, Mass., assisted by the late John W. Root, of the firm of Burnham & Root, architects, of Chicago, was submitted to them for criticism. A week's careful discussion of this preliminary scheme, during which numerous modifications, more or less important, were successively considered and laid aside, resulted practically in its adoption. To each member of the board of architects was assigned a building, and the architects who had in charge those surrounding the Court of Honor, early impressed by the vast importance of formulating a general scheme of design of such a character as to secure a monumental expression of unity without unnecessary interference with the development of a characteristic individuality in each building, agreed upon four conditions: (1) that the general form or style should be strictly classic in the best academical sense, a style intelligible to the world and one developed from the highest conditions of civilization in history,—a style, in short, which, though based upon accepted formulæ, had proved itself capable of an infinite variety of expression; (2) that the columniated order, which each might wish to use, should be proportioned to a common height of sixty feet from the terrace to the top of the cornice; (3) that the module or limit of dimensions in the plan should not essentially vary from twenty-five feet; and (4) in order to provide for a circulation under cover around the court so far as possible, that an open ambulatory or continuous portico should be incorporated as an essential part of each design at least on the court frontages, this ambulatory being practically continuous with the general level of the main terrace surrounding the great basin and canals.

As a further precaution in the interest of unity, each architect of the Court voluntarily submitted his preliminary design to his brethren for their criticism, and removed or modified, in a spirit of mutual conciliation, any feature which was found in any way to injure his neighbors by contrast, or seemed to introduce a note of discord in that majestic symphony of architecture which at once began to take definite shape in the mind of each one as an ideal to be realized at whatever cost of individual preference. If, in the history of art, such a contract had ever before been made, never before had it been so loyally and conscientiously observed. The ideals which, by the study of imagination, are created by the artist out of the most refined elements of his own spirit, are so delicately adjusted, so jealously protected, and nourished with such sensitive care that they can hardly be criticised or questioned by any one without giving pain. The pages of Vasari and Milizia, therefore, are full of quarrels of painters, sculptors, and architects; their biographies bristle with combats of words or swords. But in the great arena of the World's Columbian Exposition, where so many professional interests were vitally at stake, where the atmosphere for many months was so highly charged with artistic endeavor, nothing from first to last was written, spoken, or, so far as I know, thought of to break for a moment that fraternal peace, that harmonious and prolific coöperation, out of which alone a great and memorable architectural achievement could arise. This ordered collaboration was to each of the architects of the Court the most exciting and interesting experience of his professional life, though each one, for the common cause, was constrained to yield some feature which seemed more or less essential to the complete presentation of his design. But if these details were cheerfully abandoned, there were compensations in the suggestive criticisms of his brethren. Under these circumstances the standard of composition was maintained at a high uniform level and the friendly emulation inspired each one to his best endeavor. This coöperation was indeed in itself a Court of Honor, before which the professional resources of each member were brought to perilous trial in a judgment of peers. Each design was measured by its best capacities and was compelled in the direction of technical perfection. To this end the stipulated constraints of mutual conformity in general character for the supreme sake of unity, in themselves, encouraged a finer study of those points of detail which worked for the expression of individual character. The classic formulæ of the order which, in the history of the Renaissance, instead of creating a universal cosmopolitan type, had proved themselves elastic to the expression of the genius of races and nations in the curiously distinctive variations of the Italian, the early and late French, the German, the English, and the Spanish Renaissance, were once again, in this great experiment in America, differentiated according to the personal equation of each of the five architects of the Court. In none of the buildings was any attempt made to capriciously vary the accepted orders of architecture which were adopted in each, or to modify their proportions or details as established by the studies of the greatest masters during four centuries ; but each architect, in the development of his theme, so adapted these orders to his especial conception as to create a composition which was distinctive without losing its proper relationship with the rest. For these orders, so perfected by usage, so enlarged by their application to the service of art through centuries of experience, constitute a language of form more copious to the expression of architectural thought than has as yet been developed in our experiments with any other archæological, or with any merely picturesque or romantic, systems of decorated structure in existence.

A brief analysis of each building of the Court will show how the principle of personal independance operated in developing the component elements of that great Unity, which made the official architecture of the Exposition memorable in the history of art.

The pavilion of Administration was intended to be officially and architecturally the most conspicuous structure of the Exposition. It was accordingly placed at the intersection of the most important axial lines on the general plan of the grounds ; it closed the most important and the most numerous vistas, and was in short the great central monument and the culmination of the largest group of buildings. But its area upon the ground was very much smaller than the smallest of the structures. Its necessary predominance therefore could only be obtained by superiority of height. This was so evidently an essential point of the general architectural scheme, that all the other buildings of the great court were subordinated to it in this respect. In contrast they expressed their dignity by vast horizontal extensions and avoided every feature which might compete with this distinctive characteristic of the principal structure, which therefore easily assumed the form of an octagonal hall or rotunda of heroic dimensions, with a domical ceiling, expressed externally in a lofty dome, the hall being buttressed by four wings on the alternate sides, giving, internally, accommodation to the various complicated services of administration, and, externally, assisting in securing the pyramidal outline necessary in every monumental composition. The form of classic art preferred by Mr. Hunt in this great monument was that developed into a national style by the French builders since the sixteenth century. It was the style inculcated by the Ecole des Beaux-Arts of Paris and practiced in the best art of that nation.

On the other hand, the classic dialect used in expressing the architectural thought of Machinery Hall, or the Palace of Mechanic Arts, was rather archæological than scholastic, and appropriately recalled that developed from the civilization of the land of Ferdinand and Isabella, and Columbus. The accent of the wall treatment behind the great colonnade of the second story was distinctly Spanish, and the somewhat free and romantic spirit of that national school gave character also to the spires, which flanked the main central porches on the north and east, and to the flattened domes of the corner pavilions. But the mass of the building was corrected and its detail refined by the scholarly application of high academical principles.

The architecture of the Agricultural building was expressed in the purest and most elegant form of the original classic of antique Rome, such as appeared in the imperial palaces and baths of the best period. But the design, which, in itself, will always be remembered by students as an example of complicated but perfectly balanced symmetry, was adjusted to its special purpose and completed as an architectural composition of the first rank by a splendid profusion of sculpture and painting, expressing in poetic allegory all the pastoral and bucolic illustrations necessary to show that this imperial structure was dedicated, not to luxury, but to the manifold industries of the soil.

The same historical forms were echoed at the east and west ends of the vast quadrangle. No art less sumptuous than that of the Augustan era could have foreshadowed the magnificent double Corinthian ordonnance of the open Peristyle between the Court and the Lake, the triumphal arch of its central water-gate, and the two pavilions which extended as wings from either extremity toward the Court, supporting by their massive solidity the open architectural screen between. The art of modern times, though it has often expressed it on paper in the theses of the schools, has never given palpable shape to an architectural dream at once so pure, so majestic in scale, and so sumptuous in detail. That a composition so poetic, and answering no possible requirement of common sense or practical necessity, could have been executed in an age of Philistinism, and in the most modern of all the great cities of the world, proves that materialism and science have not taken undisputed possession of our civilization and that we are still ready, when necessary, to sacrifice to the spirit of pure beauty.

The same high spirit made possible the other architectural screen, which, enclosing the court of the obelisk on the south, carried the orders of the two stories of the Machinery building across to make connection with those of Agriculture, its opposite neighbor.

On the north side of the great Court the enormous curved roof of the Manufactures and Liberal Arts building, covering with its unprecedented span an area as large as the Court itself, arose like a mountain high above a comparatively low enveloping mask of architecture, composed of an arcade of windows, vanishing in the distance in endless perspective, without any other incident to break the dignity of its infinite monotony than that furnished in the center of each front and at the corners by vast porches of entrance. The arcade was expressed in the somewhat sophisticated, but always elegant, Renaissance used by the French artists in their last Expositition, but the porches followed the insolent grandeur of the triumphal arches of Rome, thus boldly uniting in one design the first and last expressions of classic art, twenty centuries apart.

On the same side of the Court as this vast palace of the Liberal Arts, the canal forming a street of water between, arose a structure the elements of which were in the conventional Italian Renaissance of Vignola. But the long stretches of horizontal lines in cornice and string courses, which were the distinguishing characteristic of all the other buildings, here were subordinated to a rhythmic repetition of frequent vertical lines breaking through the cornice, and attacking the sky with a series of ten lofty campaniles and four domes, the total effect being as fantastic, as full of sudden movement and vivacity, as the conditions of conformity would permit. The distinctive character of this stately pleasure house was devised to afford an appropriate shrine for the genius of the most mysterious and most restless of the elements of nature, Electricity, hardly yet broken to the harness of industrial art. The suggestions for this use of the classic formula were largely obtained from the French Renaissance of the sixteenth century, as expressed in the royal Château of Chambord

The Mines building, completing the northward closure of the Court of Honor, presented still another variation of the Roman formula. It was to accommodate a collection of comparatively coarse machinery and appliances, with crude and manufactured products of the mine. The architect consequently did not dream of making a palace of his building, but, taking a larger unit of dimension than the rest, he indicated in terms of architecture the character of his exhibit by a structure much more massive, suggesting nothing of a domestic or even civic purpose. The result was necessarily and properly a building of industrial character, purified and refined by its application to an occasion of national festival, simple, large in its parts, using in its decoration *motifs* from many classic precedents and amalgamating them in such a manner as to show how an intelligent American should adapt his inheritance of ancient and historic forms to uses never foreshadowed in the civilization of the past.

The Terminal building at the west or landward side of the great Court, like the great central hall of the Roman baths, needed large and frequent openings for ingress and egress on all sides. The Roman precedent was therefore frankly adjusted to this new service with large and noble effect.

The work of reconciling variety with unity in this great group of buildings was further illustrated and made effective by the observance of common axes, and by the correspondence of opposite pavilions and water-stairs in neighboring buildings, in the service of unity, and by the contrasts in these correspondences, in the services of variety, affording in every vista at once a stately expression of ceremonious and symmetrical order and a continual play of oppositions having all the best effects of the romantic and picturesque. In the accidental aspects of the group, domes, towers, and spires, each devised to emphasize and illustrate a problem of symmetry, combined themselves in endless surprises of perspective, which were all the more pleasing because not intended and therefore not insincere, artificial, or theatrical. To these unpremeditated results of art the innumerable accessories of landscape and water effects, the balustraded terraces, the bridges, and landing-places, the monumental fountains, vases, and groups of statuary, the kiosques and rostral columns, the banners and gonfalons, the moving pageant of gondolas and launches, the costumes and groupings of the multitude, the strains of music, the glimpses of decorative painting in the porches,—all these added an infinite foreground of movement, color, and incident, which completed this memorable conquest of art over the combined forces of ignorance, vulgarity, and commonplace,--this triumph of sentiment over materialism and Philistinism in all its forms.

It has seemed to me best, in an essay so brief as this must be, to confine myself to that part of the demonstration of architecture at Jackson Park which seemed to make the deepest impression upon the public, and which by reason of the unity of its conception seemed best capable of literary exposition. If I had attempted to include in this brief analysis the other official buildings and the almost innumerable representative structures created by foreign governments, by the States of the Union, and by private companies upon these grounds, I should have far exceeded my limits. It may be worth while, however, to state that from a professional point of view, there has never been brought together in one place an illustration so complete and so imposing of the power of architecture, not only to represent the distinctive development of races and nations in the course of empire, and the history of humanity from savagery to civilization, but to elevate and enlarge the mind while delighting the imagination. But, as no organized attempt was made outside of the Court of Honor to establish any effective unity among these buildings, the cumulative effect of their architecture was lost; each structure had to maintain its individuality in the presence of many conflicting elements,—not only without the friendly support, but often against the positive opposition of its neighbors. The result was that in the northern parts of the park we had, not a concert of many divergent but harmonious arts, but rather a museum of heterogeneous forms, in some places illiterate and poor, in others merely curious, but for the most part admirably expressive of some characteristic phase of historical art.

Above this confusion of tongues one clear lucid note of harmony arose, prevailing and sweet, in the pure and serious Greek architecture of the galleries of Fine Arts, around which these insubordinate buildings were grouped. It was an element of conciliation potent enough to restore to the bewildered mind of the beholder the peace and rest of true art.

The soul into which at least some part of the architecture of the great Exposition did not enter as an illumination never to be extinguished, could not be touched by any manifestation of beauty. The White City suddenly advanced the standard of modern civilzation, and obliterated forever whatever trails of provincialism lingered to retard the progress of our country. It made the crudest communities of the frontier hospitable to nobler and purer forms of art, and showed once for all a practicable way by which every street and square, every boulevard and avenue of our new cities may, even when composed of the simplest and most modest elements, be made beautiful by coöperation. If order is Heaven's first law, the City of the Blest is prepared for the abode of the chosen ones by the happy harmony of the celestial builders.

ELECTRICITY IN 1876 AND IN 1893.

By Elihu Thomson.

OVER a hundred years ago Tiberius Cavallo wrote in his introduction to "A Complete Treatise on Electricity" as follows: "Discoveries crowded upon discoveries, improvements upon improvements, and the science ever since that time went on with so rapid a course and is now spreading so amazingly fast, that it seems as if the subject would be soon exhausted, and electricians arrive at an end of their researches; but, however, the *ne plus ultra* is, in all probability, as yet at a great distance, and the young electrician has a vast field before him, highly deserving his attention, and promising further discoveries, perhaps equally, or more important than those already made."

This was before the voltaic battery became known, before Davy experimented with it and produced the electric arc between carbon points, before metals were deposited in electrolysis, before the effects of electric currents on magnetism was discovered, before anything was known of the extensive fields of electro-magnetic and magneto-electric induction, before the telegraph, the telephone, the electric light, the electric motor, the electric railway, the art of electric metal-working, and indeed before everything which now marks electrical science as of such great importance in our time.

I have quoted the passage above as aptly expressing a thought which has doubtless in these later years arisen in many minds. It might well have been written in the present year of the World's Columbian Exposition in view of the exemplification there made of the great progress in electrical arts during the period since the Centennial, seventeen years ago. No similar period in the world's history has in any art shown so rapid development, so extensive and refined scientific study and experiment, so active invention, so varied application, such care and perfection in manufacture, as has taken place in the electrical field within the period mentioned.

It can be truly said that as a department of applied science and engineering, electricity has taken an important place only within the past ten or twelve years. I do not forget that before the Centennial we had the telegraphic engineer, with his knowledge of batteries, lines, relays, sounders, etc.,—a sufficient equipment for his work which was then the most important electrical application.

I do not neglect the cable engineer, with his more refined and delicate methods, due to the somewhat different conditions required to be met in the construction and operation of submarine lines. Electro-metallurgy, including electroplating and electrotyping, had already become of great utility when the Centennial year opened. But seventeen years ago there were no dynamos in regular operation for electric lighting in the country, although a few machines of the Gramme and Alliance types were used abroad. Special forms of dynamo machines had been designed for electro-metallurgy, and a number of them were in use, but installed only a short time prior to 1876. Small magneto machines had been employed for a number of years previously as substitutes for primary batteries in exploding fuses for blasting and torpedo service. Electric motors, hardly worthy of the name, were here and there operated at great cost from primary batteries, but they were of insignificant power, and resembled the old designs which figured so largely in catalogues and collections of philosophical apparatus,—instructive enough in their way, but of no practical value.

What then was comprised in such electrical exhibits as were found at the Centennial Exhibition in Philadelphia? Living there, and working in the electrical field, I remember that I possessed a lively mental sense of the ultimate vast utility of electrical forces which caused me to employ the opportunities afforded for study of such exhibits as from a practical or scientific standpoint showed distinct advances. There were in the Main building a number of such exhibits as telegraphic apparatus and systems of signaling, electric clocks, burglar-alarms and the like. In the class of philosophical instruments were the usual electric models for educational purposes. Electric-key action was found applied to organs and automatic playing of the same. In Machinery Hall were to be found a few crude electric motors run by expensive and noisome primary batteries. Such motors were of but small power, and belonged to the old types, with electro-magnets and bar armatures successively attracted or repelled. The application of dynamo-electric machines to electroplating, then in itself quite a novelty, was represented by Weston machines of fair size. In these machines some of the principles of modern self-exciting dynamos were found, but the armatures were of the old-style polar pattern with a single-winding terminating in the usual pair of plates called a commutator.

But we need not further concern ourselves with these exhibits.

They gave but small indication of the future of electrical progress. There was nothing in them to indicate or suggest that the world was on the eve of great advances so soon to be made.

There were, however, two exhibits in Machinery Hall of great interest to electricians as showing types of electrical machinery which in various modified forms were soon to work revolutions in lighting and transmission of power. These two exhibits were of the Gramme and Wallace machines. Neither was remarkable for floor space covered, but notwithstanding their modest extent, and the fact that they were sandwiched in between exhibits of entirely different class and widely separated one from the other, there was that in each of them which could not fail to be of deep interest to an electrical worker. The Gramme machine itself had become known in the United States through descriptions in scientific journals, and there had been two or three machines imported into the country. Two of these I had the opportunity of inspecting a year or two before. Another Gramme machine—built at Cornell University if I remember rightly—was sent as an exhibit to the Centennial Exhibition. This was probably the first dynamo of the kind built in the United States.

In the Gramme space itself could be seen a small belt-driven dynamo, giving current for the working of a single arc lamp in its circuit, series-working being unknown at that time. In this space also there was an arrangement of circuit whereby one machine driven by the belt as a generator, furnished current through some twenty or thirty feet of wire to a second similar machine, which then ran as a motor. This was in turn belted to a small centrifugal pump which produced a small cataract of water. Experiments were also made from time to time in the heating and melting of wires by the current generated by the machines on exhibition. Special coarsely-wound low-potential Gramme dynamos for electroplating were among the interesting features. I remember the feeling of admiration,—I might almost say exultation,—with which I viewed this most unique exhibit. I also remember the enthusiasm of the attendant, whose voice held firmly to its French, and musically rolled off the catalogue of the capabilities of the Gramme machine, "la lumière électrique, la galvanoplastie, le transport de force motrice, la telegraphie," etc.

I need not remind the technical reader that the Gramme machines were the first dynamos of the true modern type constructed —the armature iron being circular in outline and preserving its relation to the magnetic field while rotating, and the winding thereon being continuous, with leads taken at intervals to a commutator of many segments. The result was a smooth unbroken current resembling that from batteries. While in these machines the core was a ring and the wire was wound over and through the same, the subsequently developed drum type differed from it only in the disposition of the closed armature winding all on the outside of the ring core instead of through its center.

The exhibit of Mr. William Wallace was unique in showing a number of different types or forms of dynamo, while the Gramme machines were substantially alike in pattern. The Wallace machines furnished current for single arc lamps, for plating baths, and were reversed and run as motors. This exhibit was very suggestive of types and forms which afterward came into general use, and fortunately the machines themselves were preserved and sent to the World's Fair in the present year, a retrospect as it were of the Centennial exhibit. Historically considered, such early models are now invaluable. Space does not permit any detailed reference to them. Some of them were used, as were the Gramme machines, for furnishing current to work large reflector lamps similar to search-lights, mounted on the roof of Machinery Hall, on occasions of evening celebration, with fireworks and other displays.

The Centennial will be remembered in the history of electrical progress on account of the fact that the telephone of Alexander Graham Bell became then for the first time known as an accomplished fact. It spoke with a small voice, it is true, at the Centennial exhibition, but the echo of that voice was heard over the civilized world. The telephone had been invented just in time to date its birth from 1876. Dr. Elisha Gray, who was close upon Bell in the invention of the telephone itself, was exhibiting his harmonic telegraph, a very ingenious multiple telegraph, but the chief interest soon centered on the instrument that could talk. With the advent of the speaking telephone there seemed to come about a general awakening to the capabilities of electricity in practical work. It prepared the public mind for the coming of new wonders. It attracted attention to other electrical enterprises and to a large extent wiped out the factor of conservatism in relation thereto. Indeed, the telephone had scarcely begun to be used practically before the announcement of the invention of the Jablochkoff candle drew attention to the field of electric lighting, and in 1878 the Avenue and Place de l'Opera, lighted by electric candles, constituted one of the great achievements of the Paris Exposition year. The Jablochkoff candle did not, however, realize expectations; it was too costly, and soon gave place to ordinary arc lamps run in series. Much pioneer work in this field was done in this country by Mr. Charles F. Brush, of Cleveland, who in 1879 had as many as sixteen arc lamps running in series from one of his well-known dynamos. A few other inventors were almost equally early in this work.

It was toward the close of 1879 that Thomas A. Edison succeeded in accomplishing the task which he had undertaken and upon which he had been at work for a year or two. This was the invention of a small electric lamp giving a light of about the same candle-power as a gas-jet, and capable of being run in multiple with many others, without requiring too large a current or too frequent renewals of the lamp. Such a lamp to be commercially successful needed to be of low first cost, economical of power, and easily reproduced in large numbers. No one, unless he has been engaged in similar undertakings, can begin to realize the amount of effort, self-sacrifice and hard work which must have been required not only to perfect the lamp itself and the details of its manufacture, but to provide suitable generators, regulators, distributing systems, mains, safety-devices, and the other things which go to make complete the electrical equipment of a lighting installation, a revolution in lighting means and methods. That Mr. Edison and his able assistants undertook and accomplished this work, the records of the numerous inventions in this field would be sufficient evidence, did we not have the fact of the actual accomplishment as a matter of engineering history.

It would be beyond the scope of the present paper to trace the history of the innumerable developments in the electrical field brought about by the effort and genius of a great army of workers, both here and abroad, between the years 1876 and the present. It must not be forgotten either that, aside from the great engineering triumphs which are from their practical benefits sufficiently prominent, electrical science, purely as a science, has expanded and progressed apace.

The advance, though a rapid one, has been sufficiently gradual to allow us to note the process as more of evolution than revolution. The great exhibitions held within the period between 1876 and 1893 have embodied more and more electrical arts and productions. Add to these the specially electrical exhibitions,—as in Paris (1881), Philadelphia (1884), and Frankfort (1891),—and the growth becomes evidently a gradual unfolding. It was natural, then, not only that the World's Fair of this year should have been characterized by progress in all arts, but that it should have become more distinctively electrical than any preceding international display. It is to be doubted, however, if many were prepared to find that such dependence on the work of the electrical engineer would be shown.

Whether we regard the lighting of the vast areas and spaces in and around the great structures in Jackson Park, or the transportation by rail or water within its boundaries, or the distribution of power for various purposes, it was through the agency of electricity that these objects were attained. In fact, the great bulk of the steam-power developed was to give motion to the dynamos for furnishing current for all the various uses to which, in these days, electricity has been applied. It is certainly no exaggeration to say that the vast amount of mechanical power developed and used at the World's Fair was mostly used for electrical purposes or transmitted electrically for its ultimate use. A vast area in the Mechanic Arts building, covered with engines and dynamos driven thereby, directly adjoined the boiler-houses and formed for the time, as it were, the most gigantic electric station ever installed. From it was sent out current for several thousands of arc-lights, for from 50,000 to 100,000 incandescent lights, for innumerable electric motors working elevators, driving machinery of all kinds, ventilating, for charging storage-batteries, for electric-welding, forging, heating, and other uses.

At the Centennial in 1876 no perceptible fraction of the power was electrically used. At the World's Fair it had become almost wholly electrical. The arrangement of the great Corliss engine at the Centennial was in the middle of the Machinery building, and by a complex system of gears and belts the power was transmitted and delivered to the long lines of shafting extending each way from this central power source. This was a limitation of service arising directly out of the absence of electrical transmission. At the World's Fair, on the other hand, power could be delivered anywhere by the use of electric motors and the moving machinery was not therefore practically restricted to a building in which a steam-engine was at hand.

In 1876 arc-lights were a curiosity and but rarely seen. In 1893 their use for illumination of streets and large spaces is almost universal. Never has there been, however, any greater display of arc-lighting than in the present year at the World's Fair. The whole of Jackson Park was dotted over with these miniature suns at night and the interiors lighted. Under the roof of the Manufactures and Liberal Arts building were five large coronas comprising many arc lamps each, a unique display in itself and an economical arrangement as well. About 2000 arc-lights, if I mistake not, were employed in lighting the gigantic structure throughout. The great search-lights, with their 60-inch mirrors reflecting the light from specially large arcs in their foci, were a striking feature of the illuminations, and these artificial sunbeams were of an intensity never before approached.

The whole art of lighting by electric incandescence has come into existence since 1876. Incandescent lamps can now be made of such uniformity of voltage and energy consumption as even to dispense with any need of photometric measurement, and indeed to require no testing or sorting after manufacture. Such lamps may consume about $3\frac{1}{2}$ watts per candle and have a useful economical life of over a thousand hours of service. An achievement like this means attention to many small details, and the doing of delicate work on a large scale. Astonishing it is to find that frequently in such work, what was formerly a delicate laboratory manipulation becomes every-day work-room practice; and here constant practice of delicate operations by even ordinary labor results finally in almost perfection.

The larger part of the incandescent lighting of the World's Fair—and the little bulbs were everywhere used and useful—was carried out on the alternating-current plan so commonly employed in cities and towns where the electric station must be at a considerable distance from the mass of consumers. Huge dynamos in the Mechanic Arts building supplied the alternating current at high-pressure in mains leading to the transformers, located in receptacles in the ground, from the secondary circuits of which the low-pressure currents were fed to the lamps connected thereto.

At the time of the Centennial, alternating currents were known, —and dynamos yielding such currents were known, being among the earliest invented,—but the transformer was unknown. The nearest approach to it was the induction coil for shocks or medical use and the Ruhmkorff coil. Soon after the invention of the telephone, however, the induction coil, modified and used in conjunction with carbon transmitters, enormously increased the distance over which speech could be successfully transmitted, and has led in

1893 to the regular communication by telephone over distances more than a thousand miles, while such is the delicacy and fidelity of transmission that it is not necessary to speak much above a whisper at New York or Boston to be heard in the receiver at Chicago.

The transformer or modified induction coil has in like manner rendered possible the economical transmission of electric energy to great distances, as the working of low-voltage incandescent lamps at miles of distance from the supply station. Otherwise the line losses and excessive cost of mains would in such cases forbid the use of direct supply. The perfection to which this useful apparatus, the transformer, has been brought by careful work may be judged from the fact that it often has an efficiency between 97 and 98 per cent. at full load. It is a simple affair of copper wire and sheet-iron, apparently, but it has required much study and experiment to bring it to the present state of perfection. There is little or no opportunity for further advance. The very great expansion of incandescent lighting both by the direct supply systems and transformer systems during late years is sure to continue at an increasing rate in the future until it includes a large proportion of the lighting done in cities and towns.

In 1876 the storage-battery was practically unknown. A crude form devised by Planté had been experimented with for a considerable time before, in the laboratory. The eminently successful use made of the electric launches on the lagoons at the World's Fair was an ample demonstration that in the past few years a new field for electrical work had been opened up. The application of the battery to boats is of course but one of the uses for the modern storage-cell. Many electric stations in Europe and a few in the United States have within late years added an equipment of batteries, to work in conjunction with their dynamos in giving out current energy when the consumption is heavy, and to absorb energy or become charged from such machines when the consumption is small. This in a large measure prevents overloading at one time or the running of the machinery with loads too light to be economical at other times. How far experience will confirm the apparent advantage of such a plan remains to be seen.

The largest single exhibit of an electrical nature, was without doubt the Intramural railway and its power-house,—together a grand practical exemplification of electricity applied to traction. It was remarkable in many ways as a piece of engineering and operated with the greatest success. It emphasized the fact that the days of steam locomotives on elevated roads in cities are numbered, and that just as surely as the horse-car has given place to the trolley-car, so must the electric motor supplant steam propulsion on the roads in question. Yet in 1876 there was no hint or suggestion of such extended use of electricity on railways—and, in fact, no such applications had been made. On the Intramural road a conductor rail with the ordinary rails for return circuit was used, the current being taken up by sliding shoes bearing on the conductor rail. The motor-car at the head of each train, besides the ordinary seats, was provided with four electric motors, one geared to each axle individually, while the controlling mechanism was arranged so as to connect the motors in single series for starting and to make successive changes passing through intermediate connections until the one having all the motors in parallel was reached, the condition for maximum speed.

This arrangement, with refinements of detail especially designed for this work, and first put into full operation at the World's Fair, gave great economy as well as flexibility in the handling of the trains. One of the best illustrations of the progress in the art of electrical engineering in the past few years was the building in the station of the Intramural road of the great direct-coupled continuous current dynamo of 2000 horse-power capacity. This machine—by far the largest continuous current dynamo ever made—was lately described by its designer, Mr. Horace F. Parshall, in this Magazine (September, 1893). It is a comparatively simple undertaking to design and construct very large alternating current generators, since in many respects they are like duplications or enlargements, simply, of the elements of smaller similar machines. This is not so with continuous current types, as the problems of armature reaction, air gap, and self-induction as affecting the working of the commutator at various loads have to be carefully estimated, while the relation of turns on the armature to number of segments in the commutator, the proper proportions and construction of the commutator itself, and the other proportions, have to be studied with great care and adjusted within limits. All this makes the production of so large a machine, built as it was without previous experiment, and its parts put together even to the assembling of the sheet-iron pieces of the armature, in the station itself, a veritable triumph of engineering skill.

Speaking generally, it is not far from the truth to say that at the World's Fair there was as much to be seen of electrical application outside of the Electricity building as within its walls, though this building was itself a temple of electricity. There were, it is true, a number of exhibits of no special significance, such as those of shifting light in masses of incandescent lamps, obtained by complicated switching appliances, colored lamps being freely used. The most artistic display of the kind was the Edison tower of lights, a creditable piece of work, the effects obtained from which were certainly very striking and beautiful. The large and varied display of modern electrical apparatus and machinery, together with the various historical exhibits were of deep interest to the student or engineer. There were found a fully equipped-modern telephone exchange and also Dr. Gray's "telautograph," which is in a certain sense an intended rival of the telephone. There also were found many types of dynamos of various makers both here and abroad. Electric motors were found applied to all manner of work,—pumps, hoists, elevators, locomotives, and mining-machinery generally. Electric arc lamps and machines, carbons, of all leading makers, were here together with exhibits showing many forms and patterns of incandescent lamp, lamps of low voltage to lamps of high voltage, lamps with one filament to lamps with a dozen filaments, lamps of one candle power to lamps of hundreds of candle-power, etc. There were full lighthouse equipments with their huge compound lenses on view. On the one hand was to be found appliances for generating electricity of enormously high pressures, such as would leap in torrents of sparks over more than five feet of clear air space, and on the other hand apparatus for electric welding and metal-working capable of yielding currents of 50,000 amperès with pressures as low as two or three volts. The comprehensive exhibit of practical work done in electric welding, including the largest weld ever made by electricity, in which the section at the weld was forty-eight inches of steel, was of great interest to many practical men.

A number of creditable exhibits of alternating-current motors of such types as single-phase, diphase, and triphase construction were found, so that the respective characteristics of this most interesting of the recently developed forms of alternating current apparatus could be examined. This class of electric machinery is of so recent production that we must look to the future for its wide application. Everywhere in Electricity building was evidence of enormous growth of electrical industries. It could be partly understood from the variety of such things as switches, safety cut-offs, wires, cables, insulating materials, found there, aside from the heavy machinery.

In the department of measuring-instruments alone, the progress to be noted was remarkable. Ammeters, voltmeters, wattmeters, recording wattmeters, standard resistances, standard cells, electrical balances and bridges, of the highest degree of excellence, were not wanting. With the refined means of measurement so provided the estimation of electrical forces and quantities may be made with a rapidity and precision hardly equalled in any other department of physical science. Enough has been said, however, to indicate what a harvest has, in the past few years, been the outcome of the earnest effort of brain and hand in the electrical field.

The one discordant note in all this great display of genuine scientific and engineering work was found in the fact that in this same temple of science,—in Electricity building itself,—naked imposture, quackery in the form of so-called electric belts, hair-brushes, insoles, and what not, had obtained a footing and stalked forth unabashed. No words of condemnation can be too strong to be applied to the parasites, who in the guise of healing and benefaction, succeed in extracting perhaps the last money from the sick and suffering for their worthless trumpery. The fact that such exhibits were found in 1893 holding place alongside of genuine electro-therapeutic appliances of undoubted merit only heightened by contrast the great shame of their presence.

Within the limits of the present article it has manifestly not been possible to do more than briefly refer to such electrical features of the World's Fair as show in concrete form the great advances which have taken place since the Centennial year.

Our technical schools and universities now devote to the teaching of electricity as a branch of engineering special courses, special laboratories, special instructors. Formerly the little electrical knowledge taught was taken up as a department of physics.

In this present year, the arc lamps in use are numbered by the hundred thousand, incandescent lamps by the million, while millions of passengers are carried daily on electric cars, thousands of horse-power transmitted and distributed by electric motors, thousands of tons of metal refined annually by electrolysis, chemical decomposition on the large scale effected, as in the production of cheap aluminum, electric furnaces are turning out their special products, such as carborundum of diamond like hardness, and electric-welding and metal-working machines are in active service in a large number of manufactures.

In summing up this great growth we must not forget the enormous extension of telephone-service systems in the past few years. So great have been the advances that it is natural to expect that in the immediate future similar rapid and important work will be undertaken and accomplished. It is difficult to play the role of a prophet unless the prophecies be made so numerous that some of them cannot fail of realization. There are, however, some things concerning future electrical development about which we can be positive. It is not likely that, except in details, much advance will be made in dynamos and motors. The efficiency of well-designed types is now so high as to leave very small opportunity for improvement. Large dynamos at full load have commercial efficiencies ranging from 95 to 97 per cent. Transforming apparatus of various types may readily have at full load a net efficiency of 97 per cent. The possible efficiency of arc lamps is about reached—and with the incandescent lamp the volatility of carbon at high temperatures governs the efficiency and life. The higher the temperature the more efficient the lamp, the more volatile the carbon of the filament, and the less will be the life of the lamp. It is unlikely that any better material than carbon will be found for the filament, and the properties of carbon as to volatility can probably not be changed.

The cost of these lamps is now about as low as is consistent with good quality and uniformity. The use of transformers for raising or lowering the line potential, permits long-distance transmission of electric energy with moderate loss. The conditions of the most efficient use and operation of electric motors as a source of power when transmitted, have been well worked out, so as to leave but little further to be accomplished in that line.

We can hardly expect, therefore, to make any radical gain in the operation of electric plant unless by the utilization of new principles in unexplored fields. A substantial gain in the economy of the development of power from fuel is of much greater moment than any possible gain in the efficiency of the electric plant. Hence electricians are looking for cheaper power, as that and that alone now means cheap electricity. For the same reason attention is more than ever concentrated on the utilization of water-power, as of Niagara itself by the Cataract Construction Company. Much future work will be done in this field, and it will give rise to many new problems for solution by the electrical engineer. The laboratory work of to-day becomes engineering work of to-morrow. Work which to-day is in the experimental stage reaches its full commercial completeness only after considerable practice with it under varying conditions. The advance work goes steadily on, but in channels which demand more and more intricate knowledge of electric actions. It is the fervent hope of many an electrician that, at no very distant time, the energy of fuel may be converted more directly into electric energy, and without the enormous percentage of loss that is involved in present methods, and that some means may be found to further transmute the electric energy into light with but a small percentage of dark heat, instead of present wasteful methods; but this is still a hope only, and there is not even a probable solution indicated.

In the department of electrical engineering work, the early future will I think witness, in addition to a constantly-increasing use of electricity for illumination, further application to chemical and metallurgical work. The field for the application of electricity to mining, for hoists, for pumping, drilling, mine-haulage, and the like, is very wide. While it is not probable that the steam locomotive for long distance railroading will soon be supplanted by electric locomotives, still there is a growing interest in these latter as applicable to special cases, such as specially-designed high-speed roads between populous centers, for tunnel work and elevated roads in cities. As feeders for trunk-lines of railroad it would seem that trolley lines are admirably adapted both for passenger and freight service, and their employment in this way will doubtless become of great importance in densely peopled localities.

There is also a field for the application of electricity stored in batteries to propulsion of road vehicles, a field in which but little has hitherto been done. Electricity generated under present conditions, involving in the first conversion into mechanical power such an enormous loss of heat energy of the fuel, will evidently not be applied as a general heating agent. In certain cases, in which the disadvantage of high cost may be outweighed by superior advantages of application, as in cooking by electric heat, there may result a considerable extension of its usefulness. But that it can be economically applied simply to heat metal bars for forging in a drop-press or rolling-machine, is not at all to be expected. In special cases of distinctly local heating of metal for welding, bending, or other process, it is now not only used with success and economy, but it would appear that many additional applications of this kind will be made in the future.

While it may be reasonable to look forward to the ability to telephone through an ocean cable under the Atlantic, it is hardly likely that we shall travel over it in ships propelled by electricity. It would indeed be possible to construct electric motors able to turn screws and propel our largest ships, but the supply of current energy to them at the rate of ten to twenty thousand horse-power, for five days continuously, would require a storage battery to be carried such as would be enormously costly and so heavy that it could not be placed aboard without sinking the ship. It should, however, be borne constantly in mind, in dealing with the subject of electrical applications, that a new discovery might at any time change the aspect of every prophecy based on present knowledge and conditions.

AN ERA OF MECHANICAL TRIUMPHS.

By Robert H. Thurston, LL.D.,

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THE World's Columbian Exposition, were this the heroic age, would be the source of a new race of demigods. In those ancient days, according to Lord Bacon: "Fathers of their Country, and other eminent Persons in Civil Merit, were honour'd with the title of *Worthies* only, or *Demi-Gods;* such as were *Theseus*, *Minos*, *Romulus* and the like: on the other side, such as were *Inventors and Authors of new Arts, and such as endowed man's life with new Commodities, and accessions, were ever consecrated among the Greater and Entire Gods;* which happened to *Ceres*, *Bacchus*, *Mercury*, *Apollo*, and others, which, indeed, was done justly and upon sound judgement: For the *merits of the former* are commonly confined within the circle of an Age, or a Nation, and are not unlike seasonable and favouring showers, which though they be profitable and desirable, yet serve but for that season only wherein they fall, and for a Latitude of ground which they water; *but the benefices of the latter*, like the influences of the Sun, and the heavenly bodies, are for time, permanent, for place, universal: those again are commonly mixt with strife and perturbation; but these have the true character of Divine presence, and come in *Aura leni* without noise or agitation." *

The great Exposition was a grand cyclopedia of the arts and sciences, and a magnificent monument to the genius of the men who made it, and to the inventors and authors of new arts who made it possible. The ancients would have erected in its midst shrines to the deified inventors of the steam-engine, the railway, the steamboat, the telegraph, the telephone, the electric light, electric machinery for transmission of power, and of the tools of modern times, as well as to the inventors of the loom and of the older arts. But, at Chicago, the product of the inventive genius and of the originator of new arts was made shrine as well as monument; and all the world went there to admire, if not to worship, the material evidences of the culmination of an era of triumphs in every department of invention, construction, and engineering achievement.

* Bacon: Lib. I.; Cap. VII.

The nineteenth century probably will always be remembered, however long the world may last and whatever may prove to be its future progress in mechanics and the useful arts, as having been the century in which the long dormant genius of invention was awakened into life and full activity. This century has seen the grandest triumphs of every department of material growth and advancement. The steam-engine, little known and hardly appreciated as a possible burden-bearer for the race, has come to carry the whole weight, practically, of modern civilization. It does the work of a thousand millions of laborers, three or four times the working force of the world; it transports a thousand tons a thousand miles, in the modern steamship, at the cost of fifteen tons of fuel; it carries the whole commissary supply of the family of a citizen of New England from the cities of Chicago, Minneapolis, Kansas City, or St. Louis at a cost of about $10 annually; it consumes a pound or two of fuel and utilizes the dormant energy thus awakened in every direction in which its aid is desired, in the performance of the full day's work of an able-bodied man. The electric current, formerly mysterious, awe-inspiring, and only destructive, where its effects became visible, has been reduced to service, and not only now acts as a courier transmitting messages across continents and under oceans, or bringing friends a thousand miles apart ear to ear, but has become the right arm of the steam-giant and applies the power of the engine to the performance of work miles from the prime motor, sets the locomotive aside, and drives the train with a thread of wire. Machinery has entered into every department of human labor, and has not only relieved the workman from labor, but enabled him to produce an enormously greater product of vastly greater excellence. The whole great Exposition, with its hundreds of acres of marvels of science and of art, was the product of what has come to be an age of machinery, in which the genius of invention has become triumphant in every department of human endeavor. To walk from the Dahomey or the Javanese village to the Liberal Arts, the Transportation, or the Machinery building, was to pass from the age of primitive man to that of the man of the nineteenth century. To go from the Street of Cairo to the Court of Honor was to pass the ages in review.

The practical outcome of this revolution of a century has been the promotion of the welfare and comfort of the whole world, the elevation of races to higher planes of life, the advancement, not only of the material interest of the world, but also the intellectual and the moral life of its people. With relief from the necessity of daily and incessant drudgery comes the power of devoting a part of life to thought, to self-improvement, to enjoyment of the comforts and of the luxuries, physical, intellectual and moral, which the new life offers. It will be interesting to note what have been the material results of this era of mechanical triumph, in which all the powers of nature have been reduced to the service of man, and in which the "art preservative of all arts" and its instrument, the printing-press, one of the most wonderful of the triumphs of invention, have given permanence and universal distribution to this extraordinary advancement.

As we look back over the single generation just ended, or back, we will say, to the beginning of the present half-century, it is easy to see that, as every economist has observed, this reduction of the forces of nature to service in the arts has, within the short period referred to, enormously increased the world's capacity for production in every field of industry. It has given the average citizen the means of securing an enormously increased proportion of the necessaries, of the comforts, and even of the luxuries, of life, as they would have been termed at the commencement of this period. Various writers estimate this gain at from 30 to 50 per cent., or more. At the prices to-day current, in many cases, the workman secures by a day's labor double the amount of food and clothing that he could have obtained then, and in many other cases he is able to procure what the wealthiest could not have obtained at any price a generation or two earlier.* Costs of transportation are re-

* Professor R. P. Falkner, analyzing the costs of products and the wage-lists of a half-century, gives the following figures for each, the tables here given being condensed from his more extensive report. The prices of 1860 are made the standard :

Year.	All articles averaged.	Year.	All articles averaged.
1840	116.8	1870	142.3
1845	102.8	1875	127.6
1850	102.3	1880	106 9
1855	113.1	1885	93.0
1860	100.0	1890	92.3
1865	216.8		

The following table shows the relative advance in wages in gold values for fifty years, taking 1860 as the base line. Relative wages in all occupations, 1840–91 :

Year.	Average.	Wages Cost.	Year.	Average.	Wages Cost.
1840	87.7	$0.75	1870	133.7	$0.91
1845	86.8	0.84	1875	140.8	1.10
1850	92 7	0.90	1880	141.5	1.32
1855	98.0	0.87	1885	150.7	1.62
1860	100.0	1.00	1890	158 9	1.72
1865	66.2	0.37			

duced both by reduction in costs of steamships and locomotives and by diminished costs of operation. The iron steamships of to-day, as built by the great constructors of the Clyde, the Mersey, and the Tyne, cost $35 per ton, where they cost $100 in the earlier days of iron-ship building. As Mr. Wells has remarked, a 3000-ton ship twenty-five years ago might have required 2200 tons of coal to transport 800 tons of freight, while to-day the same class of steamer will carry 2200 tons of freight with 800 tons of coal. Provisions are carried from New York to Liverpool, in some cases, at a half-cent per pound, and grain in bulk at three to five cents a bushel. Our great railways carry their freight often at the rate of a half-cent per ton per mile, and still make a profit. Thanks to James Watt, George Stephenson, and their successors, the United States now have 175,000 miles of railways, and our millions of square miles are interlaced with a network of these arteries of commerce.

The consumption of iron and steel is one of the best gages of progress and of the condition of a nation. The United States, now the greatest producer of the world, makes 10,000,000 tons a year, of which about one-half is made into steel, and consumes all this and still imports more from abroad. This is above 300 pounds for every inhabitant, the largest consumption, in proportion to population, of any nation on the globe. This places us in the front rank among nations, thanks to Dudley and Cort, and Bessemer and Holley, who made all this possible by their inventions, and to men like Jones and Forsythe who systematized and reduced to most perfect method the processes of the furnace and the mill, making the cost one-half what it was a few years ago, in fuel, and a small fraction, one-fifth, in dollars and cents.

Production of clothing has similarly increased in quantity and diminished in costs. According to Mr. Norcross, the increase in the boot and shoe business has been, in the last forty years, about 400 per cent., consequent upon the application of the genius of the inventor and the skill of the mechanic to the construction of largely automatic machinery. No one goes barefoot to-day, except from choice. Only the wealthy wore shoes, habitually, a few generations ago. In Dakota the labor of one man, reinforced by the power of horses and of steam, and supplemented by the inventions of McCormick and his fellows, the makers of the reaping-machine, produces between 5000 and 6000 bushels of wheat ; and this, according to Mr. Wells, is converted into a thousand barrels of flour by the labor of another man for the period of one year; while the labor of two more men deposits this flour on the dock at New York, and it is sent to Europe to compete in the market with the product of the cheapest labor and most productive soils of Africa and of India. In the times of Adam Smith, a century ago, ten persons made 48,000 pins in a day. A hundred years later, seventy machines, with three men in attendance, aided by the brain-work of some few hard-handed demigods, produced 7,500,000 better pins.

The changes within the century, which have been the changes, in the main, from semi-barbarism to enlightened civilization, and greater than in the preceding thousand years, comprise advances in every department of industry and the creation of many new arts. A century ago President Washington wore, at his second inauguration, woolen cloth costing $5 per yard, made up at a woolen factory then recently established; while his family, like all others in the land, were clothed principally in homespun. Similar goods would probably now cost $2 a yard, and the people are clothed in the product of the power-loom, then unknown, and only invented two generations later. The spinning-wheel has gone with the wooden clock, the hand-cards, the knitting-needles, of our grandmothers. Exportation of cotton began in 1784; to-day we grow 8,000,000 bales a year, exporting a large fraction, and our woolen-mills turn out 500,000,000 pounds of cloth and other woolen products. A century ago, Great Britain produced but about 75,000 tons of iron, and the United States about 30,000; to-day we see annual products of over a hundred times the larger quantity, and equal amounts in both countries. Steel was then hardly known; to-day we make several millions of tons, and at less cost per ton than was paid for the cast iron of those days. Wages of mechanics ranged from 50 to 75 cents per day, and unskilled labor 25 to 30 cents. But the workmen of that time paid from 16 to 20 cents a pound for meats; $8 a barrel for flour; calico cost 50 to 60 cents a yard, broadcloth of ordinary quality $3, hose $1.25 a pair, and "Nankeen breeches" $5.50. Luxuries, now considered necessaries of life, then cost prohibitive prices, for the average citizen. Sugar, for example, cost 15 to 20, or even 25 cents, a pound. Salt cost 50 cents a bushel, unpurified and unground. Could the people of the last century have visited the World's Columbian Exposition in 1893, they would have discovered the machine-made clock and those greatest wonders of mechanism, the machine-made watches of Waltham and of Elgin; chronometers rated to insensible variations during a year of use ; power-looms making cloths in the most extraordinary variety of patterns, producing even pictures, landscapes, and portraits, in most extraordinary perfection ; knitting-machines making garments to fit the form without seam ; and cloths of the most wonderful elasticity and softness. They would have been astonished by the cotton-gin and its work, the carding-machines for cotton and for wool, the mineral oils, the gas-light, the electric light, pressed glass and machine-made bricks, machine-made shoes of perfect form and splendid finish, and at a minute fraction of the prices of their time. Iron plows, the mowing-machine, the reaping-machine, the "self-binder,"—cutting the grain, rolling it into bundles, tying it with strong cord, and depositing it in place for the loaders, who, later, carry it to the threshing-machine--steam-driven threshers, and numerous other "farmers' helps" would astound the agriculturist of the eighteenth century. A volume,—a library, even,—would hardly suffice to describe the wonders introduced by the inventors and mechanics of the century now closing, and seen in the Exposition of 1893.

In every department of human labor and production the work of the inventor and mechanic is seen, cheapening costs and increasing the product ; giving a single man the powers of a hundred ; relieving him from the heaviest burdens; bringing him food and clothing, and every comfort in life, from across the continents and over the oceans ; developing for him new industries and diversifying the old ; until he is become infinitely safer against the vicissitudes and fluctuations of the industrial tides than ever before. The diversification of industries is perhaps the most obvious and effective of all the results of this progress of a century, and is the grandest of the triumphs of this mechanical age. It is this which gives employment to the steadily-growing population, supplies to skill and talent special fields of work, relieves the lower class of laborers of that competitive pressure which, otherwise, is sure to destroy them by thousands, and gives to the world its opportunities and its progress. The sewing-machine has given employment to a thousand where one sang the "song of the shirt" before, and has introduced a myriad new and beautiful and inexpensive fabrics and garments where the richest, formerly, could only obtain a limited number after long, patient, and killing toil on the part of the makers ; and even the accelerating rotations of the fashions, promoted by invention and varied industries, aid in giving to the poor of the substance of the rich, and in equalizing, for all, the distribution of the best of the world's most useful and continually increasing variety of good things.

In a generation, the wealth of the civilized world has doubled, and mainly to the advantage of the poor and the less wealthy classes. Wages have doubled, and the purchasing power of the dollar has, in most directions and on the average, increased 50 per cent. and more. Mr. Giffen asserts that the rich have become more numerous, the poor less numerous; and the intermediate classes are all much better cared for and richer than formerly. "The poor have had almost all the benefits of the great material advance of the last fifty years." This, as that writer remarks, is not so much an improvement as "a revolution of the most remarkable description." Where, as in cotton-spinning, a man can now do, with the aid of machinery, four or five times the work that he could have done a half-century ago, and can obtain twice the wage for his shorter day's labor, it is obvious that the world must, on the whole, have gained enormously in wealth, comfort, and happiness. And this has come largely of this direct stimulation of production due to the introduction of modern inventions and machinery, and largely, also, of that diversification of industries which the resulting increase of wealth and available time has rendered possible. The innumerable wants of the wealthy, the numberless comforts of the well-to-do, and the continually growing list of what are now considered necessaries of life for the poor, promise to make the further diversification of the industries and the widening of the new fields in which time and thought and labor have their applications, a permanent feature of human life henceforward. And this prospective increase and continual improvement will unquestionably inure, in the future as in the past, mainly to the advantage of the workers themselves. Already, as shown by Mr. Edward Atkinson, 90 per cent. of the people are at once producers and consumers, and these classes are "decade by decade, securing to their own use and enjoyment an increasing share in a steadily increasing product."* As has been so well shown by Mr. David A. Wells, "the time has come when the population of the world commands the means of a comfortable subsistence in a greater degree and with less effort than ever before; and what we may reasonably expect to see at no very remote period is the dawn of the day when human poverty will mean, more distinctly than ever before, physi-

* *Century Magazine*, 1887.

cal disability, mental incapacity, or unpardonable viciousness or laziness."

This is the lesson of the century taught at the World's Columbian Exposition. We saw there acres of steam-boilers and engines, aggregating between 20,000 and 30,000 horse power, distributing their enormous energies to 100,000 electric lights of 12,000,000 of total candle-power, driving great pumps supplying many millions of gallons of water to its myriad purposes, impelling, through the flexible arm of the electric genius, boats on the water and railway-trains on the land ; illustrating in every known way the world's progress in transportation. This great power moves innumerable ingenious and powerful machine-tools, capable of shaving iron and steel into ribbons, cutting masses into blocks, giving the most absolute perfection of form and proportion to every piece. It is these machines which make for man all the rest. The sewing-machine in unending variety ; the type-setting machine ; the printing-press, and countless others, exemplify the wonderful ingenuity of the modern inventor and mechanic ; and locomotives of more than a hundred tons weight, capable of drawing two thousand tons at a load across the continent, or of driving over the routes between great cities at speeds of fifty and sixty, and for short distances, eighty and a hundred miles an hour, show the latest and greatest of the developments of railway machinery. Models of the *Campania* and of the *Paris* show what inconceivable concentration of power into these great iron hulls illustrates the ingenuity and talent of the marine engineer and naval architect, and permits the effort of a hundred thousand horses and more, the actual equivalent, in living muscle, of 30,000 horse power of the ships of latest construction, to be applied to the driving of 10,000 tons across the Atlantic in a little more than five days,—the most wonderful of all the marvelous modern achievements of the mechanical engineer. The multiple-telegraph systems, the long-distance telephone, and the Gray teleautograph exhibit the mysterious power given by the electrician ; communicating signs, words, fac-simile letters, the sound of the voice, and perhaps even sight, ere long, across the world. The great Reynolds-Corliss and the dozens of smaller engines in Machinery Hall, and the Jacquard loom, side by side, give evidence that the days of the Greek demigods have only now really begun to find real place in history. The real demigod is he who has performed these miracles in the reduction of the great energies of nature, in sun and earth and coal-bed, of heat and light and electricity, to the service of his fellows and the race.*

Viewing this gigantic epitome of an almost infinite industrial world, one cannot but be gratified to see how nobly the inventors and the mechanics of the United States have held their own, and how well in the van they have marched in this great movement toward a better and a higher civilization. American inventors have supplied the world with many of its most valuable,—especially among the later,—improvements in the arts ; American mechanics have shown the world how production can be made most perfect and most fruitful. Studying the grand result, in this immense cyclopedia, we may well exclaim, with Charles Sumner : "This is our talisman : Give us peace, and population will increase beyond all experience ; resources of all kinds will embellish the land with immortal beauty ; the name of the Republic will be exalted, until every neighbor, yielding to irresistible attraction, seeks new life in becoming part of the great whole ; and the national example will be more puissant than army or navy for the conquest of the world."

The study of this all-comprehending cyclopedia of all the arts has thus been of peculiar value to the contemporary mechanic and inventor. Every one who visited the Exposition could see all that the world has accomplished to date, and just how this has been done ; every product of every art and manufacture, and every form of mechanism by which their production has been effected, was there placed before his eyes, and he was thus given an opportunity for comparison, not only of one with another, but of all with his own conceptions of old and new inventions, and of his own devices, in such manner that the very best methods and the most effective mechanisms have become known to him, and he has obtained a clear idea of just what is being done by the best mechanics of the world and how they are doing it. He has acquired a knowledge

* The following is a Census summary of the investments in electric light and power distributions, made up in 1891 or 1892, covering the United States only:

INVESTMENTS IN THE ELECTRICAL INDUSTRIES.

Telegraph companies	$125,000,000
Telephone companies	100,000,000
Isolated plants	6,000,000
Central-station plants	155,202,850
Electric railways	70,000,000
Fire-alarm and police-patrol plants	10,000,000
Steamboat plants	1,000,000
Sundries industries	10,000,000
Manufactures	75,000,000
Total investment	$552,202,850

of "the state of the art," as a patent lawyer would say, and is ready to go on, from its most advanced position, into new and richer fields. It is thus that the arts and inventions of the time have most surely and effectually received an impulse such as could by no other possible means have been given them. The International Centennial Exhibition at Philadelphia in 1876 illustrated this fact, and we may confidently anticipate a still more observable and still more tremendous impetus in every branch of mechanics as a result of the enormously greater Exposition of 1893. Every good mechanic and every great inventor in the land has seen the mechanism and the invention of the contemporary world at Chicago, and now sees his way, more clearly than ever, to new and greater conquests, with corresponding advantage to himself and his fellows.

The direction of the progress at the moment observable in the various arts and sciences, and the character of the inventions coming into view, and their immediate further advance, and even their limitations, so far as our present knowledge goes, may sometimes be discovered or reasonably anticipated. As the writer has sometimes taken occasion to remark, "Nature never turns a sharp corner"; inertia is as effective, in many directions, in intellectual as in physical phenomena. A line of progress marked out for a generation, or followed for a century, may usually be safely presumed to be that to be pursued in the immediate future. For example, in the case of the steam-engine, the improvements of the century have been constantly in the direction of increasing steam pressures, higher piston-speeds, greater expansion, better regulation, and, in general, continual gains in lightness, volume, concentration of power, economy, and perfection of adaptation to the special requirements of every branch of manufactures. Every invention of Watt, and every improvement since Watt having any importance and success commercially, has contributed to advancement in these lines. The immediate future, we may be sure, is likely to see further gains in power and economy, through still further rise of pressures, of expansion-ratios, of speeds of machinery; while the tentative constructions, the multiple-cylinder engine, the balanced mechanisms, the shaft-governors, the sectional boilers, are becoming accepted and standard. Perkins and Albans, a half-century ago and more, employed safely pressures of 1000 and 1500 pounds on the square-inch; we are now slowly and toilfully approaching, in regular and standard work, the "low" pressures, as they considered them, which they regarded as safe for common use. The conservatism of James Watt and his contemporaries and successors has been the retarding element in this progress; the introduction of safe forms of steam-boiler has been the countervailing element of progress. Watt thought seven pounds high enough when Trevethick and Oliver Evans would have employed a hundred; modern engineers only await the onward lead of the constructor of the boiler, and the yielding of popular prejudice, to carry the advance rapidly to its natural limit. Just where this limit will be found, no one can yet say. We may perhaps surmise that it may not be far from 250 pounds on the square inch for ordinary work. Thermodynamically, there is no limit within the range attainable with temperatures below those of softening of our materials of construction, and, as in the gas-engine, we may be able to greatly exceed, by controlling devices, even that limit. Extra-thermodynamic wastes introduce a check which seems likely,—if we can find no way of overthrowing the present type of engine and of substituting for the heat-engines electric-dynamic apparatus, like those of Nature's vital machines, perhaps,—to enormously restrict the final, the commercial, efficiency of the steam-engine, and our surmise that the limit for the immediate future may be found at not far from about fifteen atmospheres of pressure is based upon this fact.

Similarly, in transportation on the ocean, we see steady growth in size and speed of ships; but we see, at the same time, that a limit is here being constantly approached, and with continually greater difficulty, at which the ship cannot carry the machinery needed for its propulsion at the higher speed constituting that limit; unless, indeed, some new system of power-production, or of application, or of both, shall set that limit still further away. Shipbuilders are now discussing the practical possibility of attaining thirty knots an hour and of crossing the Atlantic in four days. Given the capital, that limit can certainly be exceeded to-day; but a limit remains somewhere immediately beyond, nevertheless. The famous locomotive "999" has made its hundred miles and more; but it is known to its constructors that the proportion of power expended on the engine itself continually increases with rising speeds, and that there will come a time, possibly at 150 or at 200 miles an hour, at which the machine could only carry itself, and the limit of railway transportation of passengers, with known means of application of steam-power, must certainly be found somewhere well within that point, even assuming it to be possible to commercially succeed with such enormous speeds and such consequently costly transportation. It looks very probable that a hundred miles an hour may remain a practical limit of fastest trains for some time to come. Whether the steam-locomotive will be then or ever superseded by some other, as the electric motor, probably no one can say ; although many well-informed engineers are very sanguine that this will follow, and soon. And in every department of applied science and of art, we are finding limitations, for the time at least, of our forward movement ; but we are, in every case, gradually finding ways of steady, if slow, removal of the contemporary limit.

These illustrations of progress in all the departments of industry teach, not only that continued and indefinite advance is being made in the power, economy, productiveness, and efficiency of all sorts of machinery and apparatus of industry, but also that every step is one of advantage to the race. Every new process and each new invention gives the worker the power of doing more for himself and his fellows. History proves clearly that the whole race profits by every such advance. Wages rise, and purchasing power increases steadily with the equally steady improvement in all the arts. Here and there a man or a class of men may be thrown out of their accustomed places by some new improvement ; but, in the United States at least, they speedily turn their hands to the new opportunities surely opening to them, and it is soon found that more work is made for all, and better and more fruitful industries are developed, by the change. It was feared, when railroads were introduced, that the whole British stage-coach business would be destroyed, with great loss to the people as a whole, and that the horse would cease to have work or value, if the new system were to be adopted ; but, as has been often remarked, more horses and more stage-coaches and omnibuses are employed to-day in taking away passengers from the trains in the cities of Great Britain, than were then in use in the whole country, for all purposes of transportation or of manufacture.

These are the lines of development—the work of the mechanic and of the inventor—on which the future of our country is to depend ; and it is in these directions that we are to work to make the United States the foremost among nations.

INTERNATIONAL EFFECTS OF THE FAIR.

By Edmund Mitchell, M. A.

SINCE the year 1851, when the Crystal Palace Exhibition in the metropolis of Great Britain inaugurated the system of international expositions, many world's fairs have been held, in widely-separated lands. The series runs: London, 1851; Dublin, 1853; New York, 1853; Paris, 1855; Munich, 1854; London, 1862; Dublin, 1865; Paris, 1867; Vienna, 1873; Philadelphia, 1876; Paris, 1878; Sydney, 1879; Melbourne, 1880; Paris, 1889; and Chicago, 1893. It has fallen to the lot of no single individual, perhaps, to witness all these great industrial gatherings of the nations. The several expositions were of varying degrees of pretentiousness, but it has been universally conceded that the one in Paris in 1889 eclipsed all previous ventures of the kind, both as regards grandeur of conception and brilliancy of execution. Accordingly, one does not need to be a Nestor among exhibition-goers to get at a reliable line of comparison between the great World's Columbian Exposition at Chicago and the international fairs that have preceded it.

A considerable number of the European visitors who made the pilgrimage to the shore of Lake Michigan had seen the first Exhibition in London, and had also participated in the Parisian, Viennese, and Philadelphian celebrations. Among these men, whatever their national predilections and their views on points of detail, there was a unanimous and freely-voiced consensus of opinion that the City of White Palaces in Chicago has never had a compeer as regards architectural magnificence. There might be conjured up to the mind's eye individual buildings in other parts of the world that were perhaps more strikingly beautiful than any of the structures in Jackson Park, but it was universally allowed that never before had there been such a massing of glorious palaces, such exquisite grouping of noble buildings amidst an unrivalled setting of lake and lagoon, splashing fountains and balustrated bridges, statuary and stately colonnades, islands and avenues, landscape designs and floral effects.

Never in history had such an architectural panorama been conceived by the brain and fashioned by the hand of man. The surpassing loveliness of the night scene, when the Court of Honor and the Wooded Island were lit up by myriads of electric lamps, dotting out every curve and angle in the beautiful façades of the buildings, tracing with lines of fire the Grecian Peristyle with its noble columns and magnificent surmounting statuary, outlining in the heavens the graceful dome of the Administration building, dancing amidst the rainbow-hued spray from the electric fountains, running around the balustrades that encircled the gleaming waters of the lagoon, shedding over lake and verdant turf and dazzling white pillars alike a soft effulgence that paled the moonlight, while gigantic search-lights stole ghost-like across the field of view, sending cones of luminosity over the broad bosom of Lake Michigan, causing distant domes and minarets of the Midway Plaisance temples and palaces to glisten like carven mountains of ice, penetrating beyond the roaring city to the silent prairie where the buffalo used to roam and the coyotes held village council—this assuredly was a grand and glorious spectacle that never before even in faint outline had been presented to the eye of man. It was, by universal admission, the veritable realization of an artistic dream that heretofore had existed perhaps only on the pages of some Arabian romancer.

Writing in London, fresh from an eight-months' sojourn in Chicago, and with the picture of exquisite loveliness indelibly impressed on my mind, I am simply amazed at the amount of misconception among stay-at-home Englishmen of what the Columbian Exposition really was. Comparatively very few Britishers crossed the ocean to behold for themselves the grandeur and magnificence of the White City. The British press has done little or nothing to supply an accurate idea. The flight of newspaper correspondents from across the Atlantic, that descended upon Chicago for the inauguration on May 1 and then took wing after a rest of only a week or ten days at the Fair, carried back reports of incompleteness in construction and installation the reproach of which was wholly removed in a very few weeks' time. When the culmination of success was reached, there were few special correspondents on the ground, and the subject of the World's Fair had been virtually dropped in both the metropolitan and the provincial press of England. Other causes had contributed to this journalistic "happy dispatch" accorded to the great Chicago enterprise. Soreness over the McKinley prohibitive tariff had undoubtedly caused many of the leading manufacturers in England to hold themselves entirely aloof from the exhibition, and in the great industrial centers the interest of participation was accordingly absent. Moreover, the newspapers of New York are, of all American journals, the ones most commonly read in Great Britain, and the not too kindly comments of its daily press in the early weeks of the Fair helped to root the idea in the minds of the English public that the undertaking had proved a comparative failure. But the men who actually saw, and who are therefore the only competent judges, have been cordial and unstinting in their praise.

In my own case the practical aspects of the World's Fair impressed me most. For example, to visit the vast Transportation building and its annexes, and to learn that this was an entirely new department in the history of international exhibitions, was a perfect revelation. The marvelous variety, the historical completeness, and the splendid classification of the exhibits in this section, making transportation one of the grandest fields for study in the whole Exposition, appeared to be the result of twenty years of gradual improvement in preparing such a display, rather than what it was virtually,—an experiment. The achievement of such results under the circumstances forcibly showed the foresight, enterprise, and organizing ability of the men at the head of affairs in Chicago. Again, it was truly marvelous to witness in the Electricity building the dynamos and other appliances which were shown at the Philadelphia Exhibition of 1876, displayed side by side with the most modern electrical machinery, their relation to the latter being simply that of *archæological curiosities.* It was a strange sensation to lay one's hands upon the first telephone, the first phonograph, the first arc lamp, the first electric motor,—to look upon them and examine their parts with much the same feelings as one stands within the pyramids of the Nile and inhales the musty atmosphere impregnated with the dust of mummies five thousand years old, and yet to realize that they are, each and all of them, but inventions of yesterday. No such object-lesson, showing the giant strides of the youngest of all the sciences within the past twenty years, and indicating its vast potentiality in the near future, was ever afforded. Similarly, in mining, machinery, manufactures, viticulture, pomology, agriculture, and dairying, practical lessons of a hardly less impressive character were everywhere to be learned by the observant visitor.

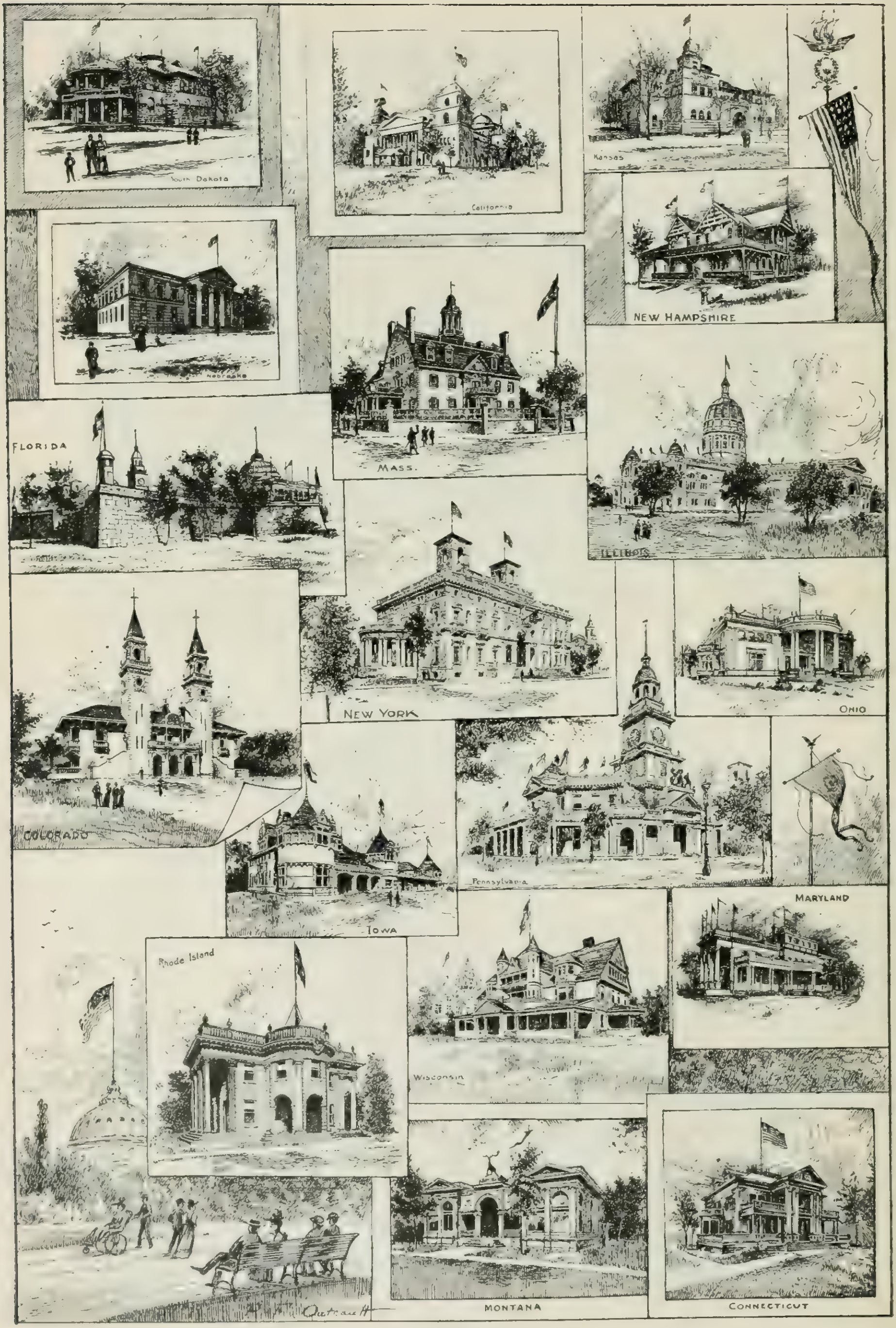
It has frequently been contended that international exhibitions have done little permanent good to mankind,—that they are really carnivals of pleasure, that industry does not profit by the lessons they profess to teach. The complete falsity of such an argument must have been borne home to the mind of every one who made anything like a conscientious study of the Chicago World's Fair. Let me give one or two specific instances of ideas being exchanged at these exhibitions ; and in doing so I shall of set purpose select small things, to show that even the most minute details do not escape the lynx-eyed visitors. At Philadelphia, in 1876, Switzerland was completely cut out by America in the department of watch-manufacture, the machine-made article of the latter country eclipsing the hand-made product of the former. At Chicago, in 1893, we witnessed the Swiss artisans making watches by the aid of all the latest and most delicate American machinery, and in not a few instances beating the United States manufacturers with their own tools. Had not an invaluable lesson been learned by the Swiss in this case ? Similarly, in the section of dairying, a number of beautiful new appliances, such as the Babcock milk-tester and the Scovell sampling-tube, were shown in operation, and most careful and elaborate descriptions of the experiments and processes, together with specimens of the machines, were promptly dispatched to Denmark, Sweden, Australia, the Cape of Good Hope, and other countries where the production of butter and cheese is one of the chief industries pursued. The outcome cannot fail to be an appreciable improvement in the dairying resources of the world. Again, on the Chicago lagoons the picturesque but antiquated Venetian gondola was seen side by side with the far more speedy and effective electric launch, with the result that we read of the latter vessel having been introduced on the canals of the Italian city. Similar examples of adoption following close on the heels of exhibition could be indefinitely multiplied, but the three cases I have quoted show with sufficient clearness that a well arranged international exposition becomes virtually a clearing-house of ideas for the whole civilized world.

To my mind, also, not the least valuable result of the Chicago World's Fair was the spirit of fraternity diffused among men of many varied races. Sentiments of brotherhood seemed to be in the air. In this respect Chicago gained an undoubted advantage over Paris, Vienna, and every other European center of population. On the soil of America there is no field for international bickerings and jealousies. At Chicago German and Frenchman, Englishman and Russian, Turk and Bulgarian, met together on every festive and ceremonial occasion, and came to know each other, to appreciate each other, and to regard each other as warm personal friends. More especially was this happy result brought about by the excursions from Chicago into the surrounding country proffered by the American people among many other hospitalities to their visitors from abroad. Notable among these was the trip to the wheat-fields of North Dakota organized by the Chicago, Milwaukee and St. Paul and the Great Northern railway companies, on which occasion men of twenty nine different nationalities, speaking fifteen different languages, fraternized together during a period of nine days and became intimately acquainted—an incident which, I venture to think, is almost without parallel. The spirit of brotherhood engendered by this close association was shown at Gretna, a village on Canadian soil, where the stars and stripes of the United States and the union jack of Great Britain and Ireland were saluted, and the happily expressed sentiment, "May the Old Glory of the New World always float side by side in amity with the Older Glory of the Old World," was cheered to the echo by Americans and Englishmen, Frenchmen and Russians, Germans and Poles, Italians and Spaniards, Swedes and Norwegians, Austrians and Turks, representatives of every South American republic and colony, and men from far away Australia, the Orange Free State, and Japan. It augurs well for the federation of mankind that such a chord of friendliness should have been struck and echoed through so many countries of the world. A little leaven leaveneth the whole lump, and the scene at Gretna on August 28, 1893, is one that will live long as a kindly memory in every corner of the globe.

I would say, in summing up a few of the special features of the World's Fair, that Chicago itself must not be forgotten. To the thoughtful observer from abroad, perhaps of more supreme interest than all the exhibits within Jackson Park was this young giant city of the West, with its striking architectural features that mark a distinct epoch in building engineering, with its teeming and polyglot population, with its phenomenally rapid commercial growth, with its web of concentrating railways, with all its feverish energy and enterprise. No foreigners can have lived in Chicago during the summer of 1893 without being profoundly impressed by the greatness of the American people as evidenced in these sons of the West, their throbbing mental activity, their courage, their resourcefulness, and their indomitable perseverance. This lesson is not the least important result of the Columbian Exposition.

VIRGINIA STATE BUILDING (MT. VERNON).

THE FERRIS WHEEL.



A GROUP OF STATE BUILDINGS.

BUILDINGS OF GREAT BRITAIN AND FRANCE.

BUILDINGS OF NORWAY AND SPAIN.

INDIA AND CEYLON BUILDINGS.

BRAZIL AND VENEZUELA BUILDINGS.

GUATEMALA AND COSTA RICA BUILDINGS.

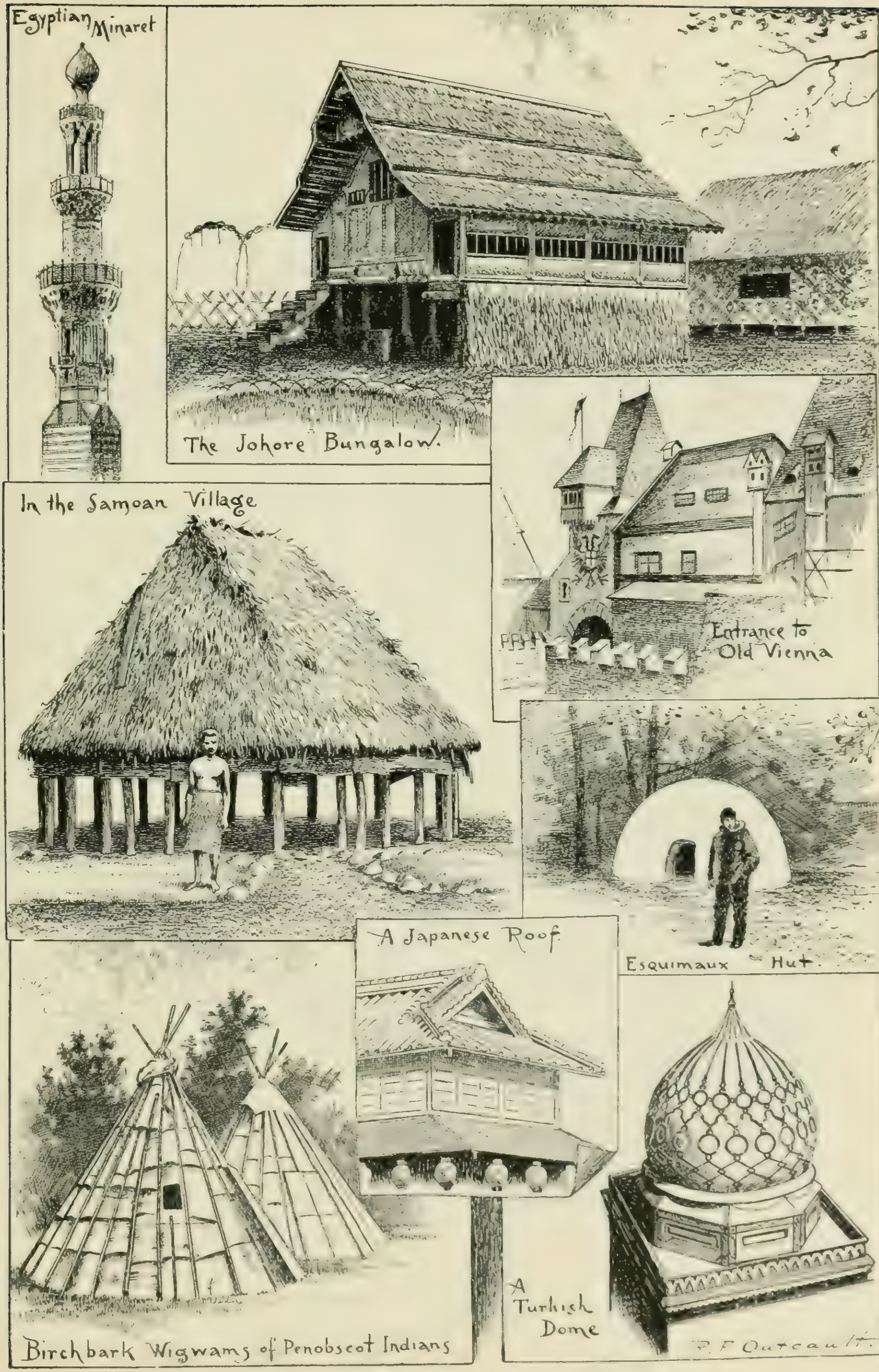
THE CANADA BUILDING.

NEW SOUTH WALES BUILDING.

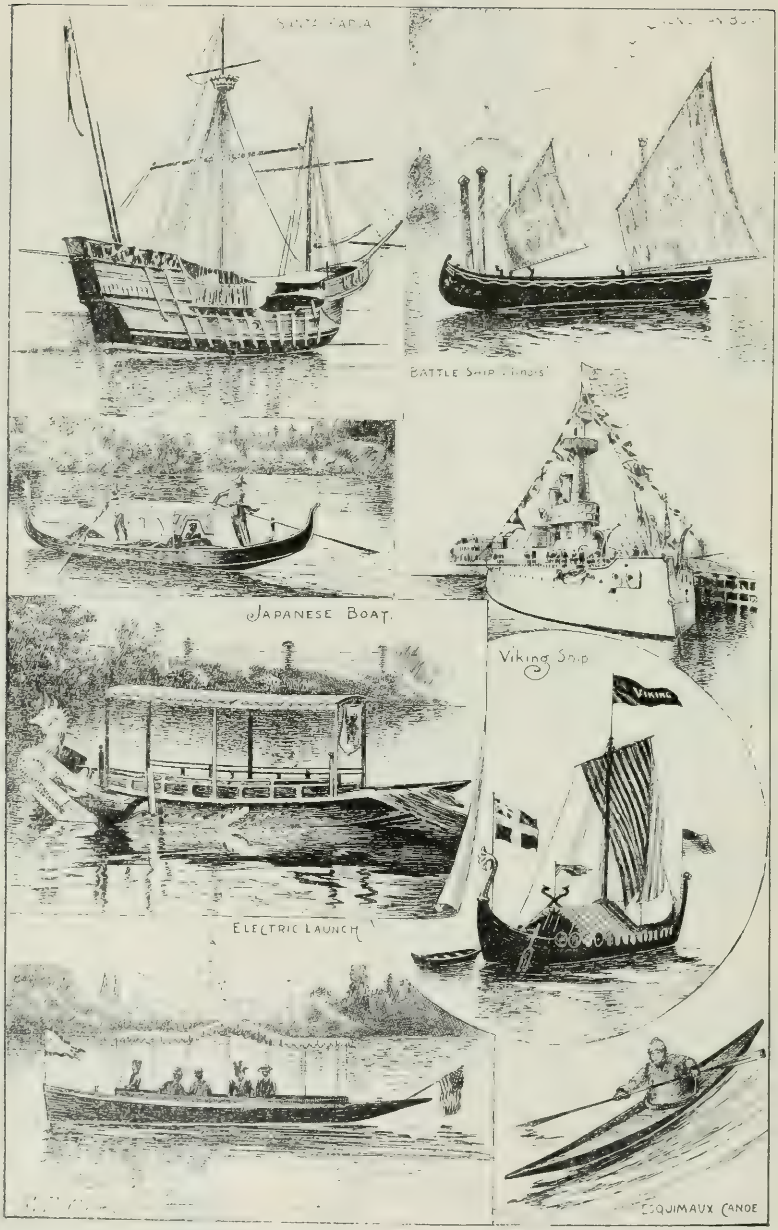
THE FORESTRY BUILDING.

THE TURKISH BUILDING.

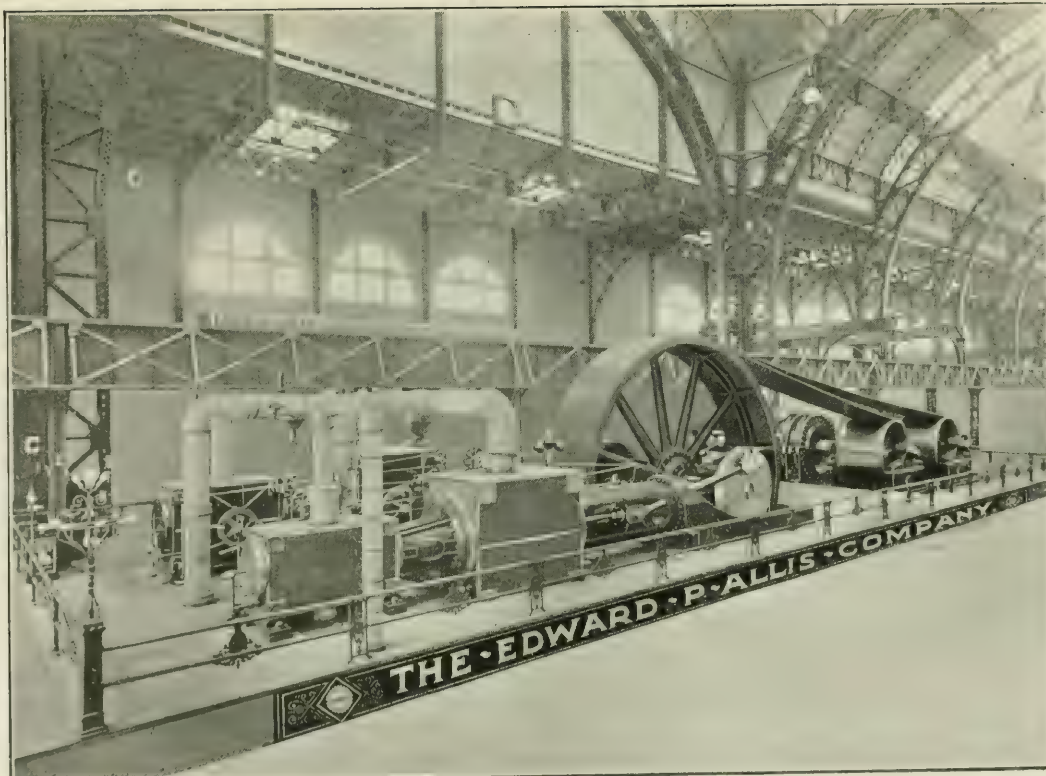
THE SWEDISH BUILDING.



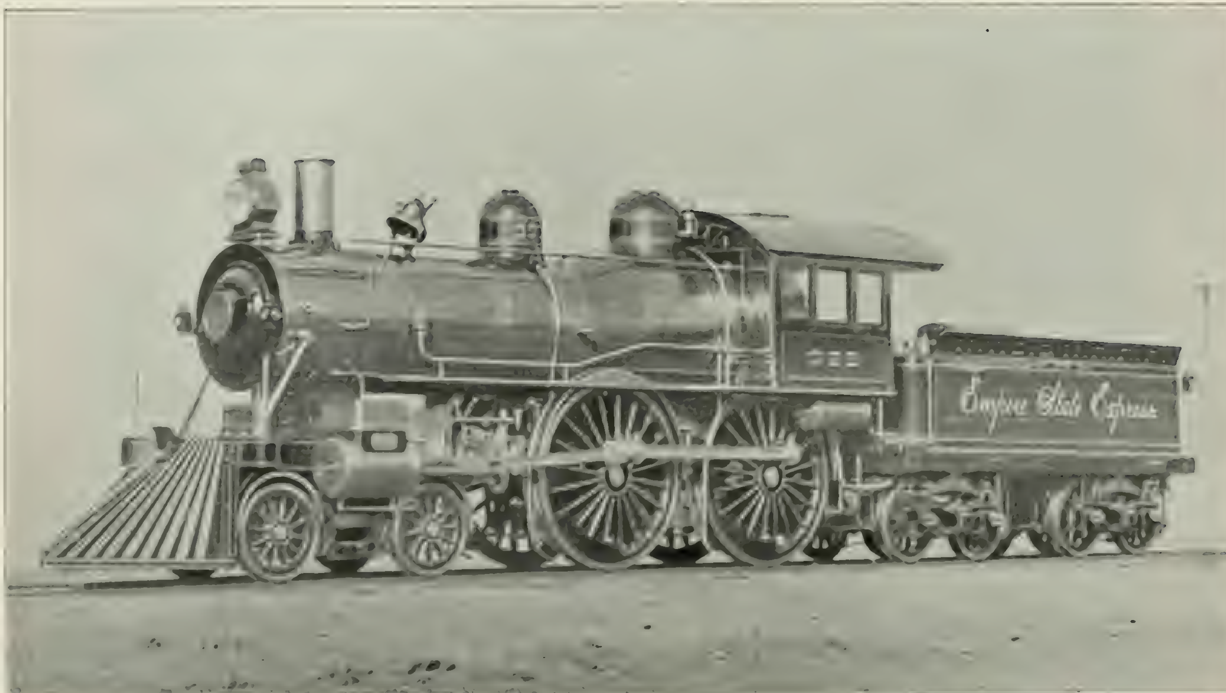
FRAGMENTS OF ARCHITECTURAL ODDITIES.



A COLLECTION OF VIEWS AT THE FAIR.



THE GREAT ALLIS ENGINE—MAXIMUM RATED CAPACITY, 4000 H.-P.



NEW YORK CENTRAL PASSENGER ENGINE NO. 999—RECORD OF 112 1-2 MILES PER HOUR.

SPECIAL "HIGH-SPEED" PASSENGER LOCOMOTIVE, 1893—BALDWIN LOCOMOTIVE WORKS.

GERMAN GOVERNMENT BUILDING.

THE MINING INDUSTRY AT THE WORLD'S FAIR.

By Rossiter W. Raymond, Ph. D.,

Secretary of the American Institute of Mining Engineers.

NOW that the World's Columbian Exposition has passed into history, description of its wonderful beauty and spectacular attractions are perhaps out of place. To those who saw it, they would be superfluous ; to those who have lost that unique opportunity, they would be irritating. At all events, such descriptions have been abundant enough, during the past six months ; and I do not purpose to add to that abundance now.

The department of Mines and Mining, like the Exposition as a whole, presented many ingenious and striking features, calculated to impress the casual beholder and to emphasize the more permanent truths which they conveyed in object-lessons. In this retrospect it is more important to consider the substantial truth than its pictorial expression ; and therefore I shall here consider, in the main, two questions : How complete was the representation of the mining industry at the Exposition ? What general reflections does this exhibit suggest?

It seems necessary to remark at the outset, that the mining industry is, for the purpose of a classified exhibition, very vaguely defined. No doubt mining, like fishing and fish-breeding, hunting and cattle-raising, agriculture and forestry, is one of the primary productive industries, and deserves a department to itself. But such a department inevitably comes to contain exhibits of metallurgical and chemical manufactures and of various machinery, which are represented also (and perhaps more completely) in other departments. This is especially likely to occur when, as in this case, the available room is crowded with the independent displays of nations, States, and individuals, whose means, material, and methods cannot be rigorously prescribed.

Thus it came to pass that the mineral resources of many nations and States were illustrated in their own buildings, rather than in the Mines and Mining building ; that the principal geological sections and models of the United States survey were in the United States government building ; that many machines employed in mining were to be found in Machinery Hall or in the Electrical and Transportation buildings ; and that the work of technical schools in mining and metallurgy was illustrated chiefly in the galleries of the

Manufactures and Liberal Arts. On the other hand, the Mines and Mining building contained the magnificent exhibit of the steel-works of the brothers Stümm in Germany, and scarcely anything from American steel-works. The big Bethlehem hammer, and the displays of that and other companies, were in other places; while Krupp had a palace to himself.

This was to have been expected; and I mention it, not as a blameworthy defect, but rather in order to express the pleasurable surprise experienced by all mining engineers and metallurgists who visited the Exposition, at finding the exhibits in the department of Mines and Mining so large, well-arranged, comprehensive, and instructive. To say that this department, as a whole, surpassed in these respects anything hitherto offered in the same line on a similar occasion is to say but little; for the mining departments of previous expositions had set no very high standard of excellence. Moreover, no very high expectations were entertained concerning this one; and it is no secret to those who know anything of the interior history of the management at Chicago that the highly creditable success achieved in this case was due to the indomitable energy and administrative genius of J. F. V. Skiff, its chief, who secured for his department both the respect of his colleagues and the support of the public which it represented.

Even a general survey of the contents of the Mines and Mining building can scarcely be compressed within the limits of this article. For the purpose of a summary statement of first impressions, such as one might give in an off-hand talk with a friend, I would class the whole under the following heads:

I. Mining resources.

II. Products and processes, machines and apparatus, both mining and metallurgical.

III. Exhibits of methods and means of instruction, including statistics in graphic or dimensional forms.

IV. Spectacular exhibits.

The prevailing principle of arrangement being necessarily geographical, nearly all of the classes were scattered throughout the building, so that the completeness of any one of them (except the first) could not be easily estimated. My impressions, based upon a number of visits, but not upon a thorough detailed study, are therefore stated with some hesitation and self-distrust.

The representation under the head of mineral resources was thoroughly good as regards most of the States and Territories of the Union, astonishing as to some foreign countries,—notably New South Wales,—fairly comprehensive as to others, such as Canada and Mexico, and far from complete, though still interesting and extensive, with regard to Great Britain and European nations. With the exception of the magnificent exhibit of New South Wales, which can only be interpreted as the expression of colonial pride and public spirit, the relative excellence of the various geographical divisions in this case was, in the main, what might have been expected upon due consideration of the two factors of distance and commercial relations. Naturally enough, those regions the mining industry of which seeks American custom or American capital, presented the most abundant display of their mineral resources. While this legitimate motive may not be depreciated, all the more credit is due to New South Wales for the superb and comparatively unselfish contribution sent as a greeting to the New World from the newest. Apart from this international compliment, which Americans are not likely to forget, the exhibit was an overwhelming revelation of the natural wealth, industrial energy, and inevitable future greatness of the Anglo-Saxon antipodes. History bears witness that the mere mining of the precious metals, while it has often been the starting point of new conquests of civilization, has never built up prosperous and permanent commonwealths, in the absence of the necessary bases for other industries. It is the surest indication of the assured future of New South Wales that her product of coal already exceeds in value her product of gold. If she did not possess that element of power, all her gold would not buy it for her.

Similar reflections are suggested by the exhibits of some of our own States, heretofore associated in the public mind chiefly with gold- and silver-mining. It is difficult to produce a fresh sensation by the mere display of nuggets and rich "quartz" specimens; and in the splendid exhibit of Colorado, even the collection of gold nuggets from Breckenridge and San Miguel, the most valuable, perhaps, ever brought together, was less impressive than the wonderful balustrades and columns of Colorado marble, sandstone, granite, onyx and alabaster, and the specimens of coal, asphalt, petroleum, and iron-ore, which testified to the rich variety of the natural wealth of that favored State. The same might be said of other parts of our great West, including California, and excepting only Nevada—which, unless I am mistaken, was not separately represented at all in the building.

The principal general impression derived from this geographical exhibit of mineral resources is that no nation can claim a monopoly of any really important mineral product. It is ridiculous to talk of silver as "American," and gold as "British." The commercial corollary of this theorem is, that no nation, by itself, can "corner the market" or fix the value of any important mineral product. The exhibit of amber from Germany is the only exception that I remember seeing. As to the cryolite of Greenland (which I did not see), it is a temporary monopoly, and deposits of the mineral are known in the United States ; and as to tin, it is not produced by one nation only, although this country produces at present only specimens of the ore for exhibition !

Among our own States, there is an equal absence of monopoly, the only exception to which, so far as I recollect, was furnished at Chicago by the fresh-water pearls of Wisconsin. And if pearls should prove essential to prosperity, I have no doubt they will be discovered or manufactured by other enterprising States.

Perhaps I may be told that I should have included, as a substantial exception, the anthracite of Pennsylvania ; and I must admit that, considered apart from other coals, anthracite does constitute for that State a practical monopoly, although it is commercially so restricted by competition that it has never returned large profits upon the capital invested in mining and transporting it. I might, however, defend my omission to mention it above, by calling attention to the mining of local deposits of anthracite in New Mexico and Colorado, which, although it can enter into no commercial competition with the product of Pennsylvania, may furnish to the cities of the Rocky Mountain region a domestic fuel of no small value from the standpoint of cleanliness and comfort.

Finally, the immense abundance and wide distribution of the economically important minerals of the United States, as illustrated at Chicago, was more profoundly impressive as an augury of the future than as an evidence of the present. Especially in the matter of coal and iron-ore, it is evident that we possess much more than can be immediately exploited to advantage. No doubt the most favorable points will continue to be energetically attacked and more or less wastefully exploited. The newly discovered iron-ore deposits of the Mesaba range in Minnesota will doubtless furnish a striking instance of this process ; and some other sources of supply will have to be checked until the first gush of these overwhelming fountains is over. But the moral is, that succeeding generations are to have abundant opportunities of profitable labor; and we need not complain that we are unable to exhaust or even to exploit at once all the treasure of a continent.

The actual mining industry was admirably represented at Chicago by the obelisk constructed by Dr. David T. Day, statistician of the United States geological survey, which consisted of superposed cubes, each representing the quantity of a given mineral produced in this country per second of time.*

In products and processes, machines, models, and apparatus, both mining and metallurgical, many interesting exhibits were made in the national and State pavilions. The finest, I think, was that of Germany, which in this department, as in so many others displayed an astonishing liberality and public spirit in the admirable contributions which she made to the Exposition. The magnificent trophies and decorative arrangements of iron and steel shapes representing the great works of the brothers Stümm, visible from all parts of the building, deeply impressed the beholder, and prepared him to find in the displays of less imposing proportions, such as the models of collieries, salterns, etc., and the collections of crude and manufactured mineral products, equal evidence of German thoroughness and skill.

It must be confessed that there was no systematic and complete exhibit of mining and metallurgical methods and apparatus, even in the well-ordered German section. From the United States there were a good many (yet, after all, but a few) interesting machines, rock-drills, stamp-mills, etc., some models illustrating recent processes, like the Russell lixiviation or the Hall aluminum process; some applications of electricity, like the Jeffreys coal-cutter or the underground haulage-system operated beneath the building.

The Cape Colony exhibit of demantiferous earth and diamond-washing machinery, might almost be called American; for American engineers are largely engaged in the diamond-mines, and Tiffany's diamond-cutters constituted an American appendage even more interesting than the African show.

There were here and there some good mine-models, such as those of some of the Lake Superior iron-mines, and especially those of the "Copper Queen" in Arizona. But there was not, as there ought to have been, a collection representing all kinds of mine-

*See the appendix to this paper.

models, and permitting their merits for various purposes to be compared.

A full-sized Bleichert cable-tramway, built and operated by an American concern,—the Trenton Iron Company,—attracted much attention as its buckets and carriers traveled to and fro, outside of the building, all day long. There are many of these aerial tramways running in Europe, and not more than fifty in the United States. But they are rapidly coming into favor ; and the cheapening of transportation which they will effect, particularly in mountainous regions, is to be no small factor in the prosperity of mining hereafter.

Among manufactured products, nothing in the building was more striking than the cast-iron statuettes and other objects exhibited from Russia. These wonderful castings have all the sharpness of bronze. They are rivaled, if not surpassed, in delicacy by the famous Ilsenburg castings from the German Harz. The Ilsenburg exhibit, however, was unfortunately not in the Mining, but in the Manufactures, building ; and the partisans of each of the rival exhibits could only travel from one to the other, and bet dogmatically upon their favorites.

This is a good place to mention the exhibit of the Standard Oil Company, which occupied the gallery across the north end of the building, and constituted one of the most costly, attractive, and instructive displays in the department. It is whispered that the installation cost $70,000 ; but this is a trifle compared with the expense of furnishing lubricating-oil free, to every machine running within Jackson Park. This latter piece of generosity and advertising skill cost perhaps $150,000.

The scientific arrangement and completeness, no less than the elegance in detail of this exhibit, reflect much credit upon its designer, Dr. David T. Day. True, he is reported to have received *carte blanche* as to expenditures ; but it takes genius to use *carte blanche*. In Dr. Day's admirable scheme the geological and geographical conditions, the method and means of production, manufacture, and transportation, and the varied products and applications of petroleum, were presented side by side in comprehensive survey. From the little vial containing a gill of brown oil from the Drake well of 1859 to the big glass bottle (the largest ever blown) containing a barrelful of the crude petroleum of to-day, and surrounded with radiating lines of cases, representing in quantitative proportions the products now derived from that unit of crude material—the gasoline, naphtha, illuminating and lubricating oils, paraffin (candles, soaps, artificial fruits and flowers and chewing gum), and what not besides,—what an interval of industrial progress! This brief paper of mine skims the surface of things lightly, and I dare not sink it with the weight of statistics; but whoever would form a conception of the magnitude of this industry in the United States has only to multiply mentally by 54,000,000 the products of one barrel of crude petroleum as shown in this exhibit, to arrive at the business of 1892. A simple formula: yet how many of us can multiply by 54,000,000 "in our heads"? Perhaps it is more impressive to say that after deducting the amount exported, we are forced to conclude that every one of us, man, woman, or child, consumes annually, directly or indirectly, in some form, of the long list from gasoline to chewing-gum, half a barrel of petroleum annually!

The Barber Asphalt Company—which has now become the sole owner, as I am informed, of the famous Trinidad deposit—displayed the source, manufacture, and finished form and practical excellences of its asphalt pavement, as well as the extent of its business, in a handsome pavilion, which was never without groups of interested visitors.

As I have remarked already, the exhibits of technical schools were mainly to be found in the galleries of the Manufactures and Liberal Arts building. But the Mining building contained many features of instruction. To say nothing of the relief models of New York State and other regions (and especially the exhibit of Ward's famous Rochester workshop), or the extensive classified mineral collections (especially Mr. George F. Kunz's wonderful array of gems, antiques, and curios), there was a noticeable attempt, on the part of the majority of the exhibitors, to convey quantitative information. The pyramid of the United States geological survey, already mentioned, was a type of such endeavors; and pyramids of cubes representing the amount or value of certain aggregates of mining products, were frequent in the building. The great central obelisk of anthracite, reproducing the exact thickness and structure of the Mammoth coal-bed, was a striking instance. And this prevailing tendency to satisfy the student, as well as amuse or astonish the spectator, rendered the Mining building one of the most profitable departments for repeated visits and leisurely examinations in the whole Exposition.

It is difficult to draw the line separating the class of spectacular exhibits from some of the foregoing. If we may judge from the daily throng of visitors, no other spectacle in the building was so attractive as that of the diamond-washing and diamond-cutting. Yet this was a legitimate exhibit on a working-scale of an actual industry, except, perhaps, that the Zulu on guard was dressed a little more than usual. On the other hand, the silver statue of "Justice," in the Montana pavilion, was purely spectacular. The figure would have looked equally well in spelter, and better in bronze. Nor can it be claimed that the handsome Kentucky castellated doorway, all built of cannel-coal, was indicative of anything in particular as to the qualities of cannel-coal or the resources and industries of Kentucky. Similar remarks might be made concerning the miners' cabins, caverns, and trophies of various kinds which adorned many of the State pavilions, and often revealed the astonishing decorative capabilities, in skillful hands, of unpromising crude materials. In this particular line, however, agriculture unquestionably took the lead at Chicago. The Iowa "Corn Palace" went about as far as art can go in that direction. Such displays are by no means to be disparaged. On the contrary, they confer beauty and interest upon the dull details of fact. But "after the ball is over," they have played their part, and need not be further recalled, save as a pleasant memory.

In conclusion, let me suggest, without much explanation or argument, a few reflections based upon the foregoing outline.

The Hon. Abram S. Hewitt, in his notable presidential address, delivered in 1876 before the American Institute of Mining Engineers, on "A Century of Mining and Metallurgy in the United States," enumerated as the leading epochs of our history in this department, (1) the erection in 1794 of the first steam-engine in America; (2) the rise of gold-mining in the southern States, about 1828; (3) the opening of the anthracite fields about 1820, and the introduction of anthracite as a blast-furnace fuel, in 1839; (4) the use of raw bituminous coal in the blast furnace, in 1845; (5) the development of copper-mining at Lake Superior, in 1845 and subsequent years; (6) the discovery or re-discovery of gold in California, in 1848, followed by the inauguration of gold-mining in Oregon in 1852, Arizona in 1858, Colorado in 1859, Idaho and Montana in 1860; (7) the commencement of the regular production of quicksilver at New Almadon, about 1851; (8) the announcement of the Bessemer process in 1858; (9) the development of hydraulic mining, about 1853; (10) the rise of Lake Superior iron-mining, about 1856; (11) the development of the Comstock lode, in 1859, and the vast extension of the silver-mining industry which has followed; (12) the innumerable advances in all departments of the iron and steel industry, including the Martin open-hearth process, introduced into the United States by Mr. Hewitt in 1868.

To this list, the orator added a reference to the work of the numerous technical schools of the country, and the potent influence of such societies as that to which his address was delivered.

The rise of the petroleum industry in 1859 is omitted from Mr. Hewitt's catalogue. Perhaps it did not occur to him as strictly a branch of mining or metallurgy. But he includes in his statistical table the product of petroleum; and it may fairly be counted as not only a branch of mining, but as an epoch-making industry, the timely rise of which, at the time of our Civil War, contributed mightily to the financial strength of our imperiled Union. With this addition, Mr. Hewitt's list is complete.

The seventeen years that have elapsed since he summed up the history of a century have added not a few fresh elements of national strength and progress. From the standpoint of political economy, the most important, I think, is the development of the phosphate industry of South Carolina and Florida, the effect of which has been not only to enrich those States, but to give a vast extension to the southern cotton-belt, and a new lease of life to the declining agriculture of the Atlantic regions, hard-pressed as it was by the competition of newer and richer soils in the West, aided by the cheap transportation of our omnipresent railway-system. This great new industry was represented at Chicago in State exhibits, the significance of which no thoughtful student could overlook.

Another new (though narrowly limited, and hence less profoundly important) industry of the last few years is the mining of fibrous talc in St. Lawrence county, N. Y., and its use in the manufacture of paper. Another is the production of nickel in Canada, and its shipment in large quantities as matte, to be further treated in the United States.

The use of electricity in both mining and metallurgy has made astonishing advances in little more than five years; and the end is not yet. Its most striking achievement, perhaps, has been the cheapening of aluminum from $12 to less than 50 cents per pound.

Machinery for drilling, coal-cutting, surface-excavating, and especially for the handling of large quantities of bulky crude material, like ore, limestone, and coal, has had a remarkable development, both of design and of use, since the Centennial year ; and to the consequent increase in the effectiveness of labor, more than to the discovery of new processes or the opening of fields not known before, is due the recent progress of our mining industry. Indeed, such exposures of national resources as that with which the Mesaba iron-range now dominates the iron-ore market would lie unused but for the facilities of excavation, handling, and land-and-water transport, which bring that region into close commercial touch with supplies of fuel and centers of trade.

APPENDIX.

THE details of Dr. Day's ingenious obelisk-pyramid-spire, as furnished by him, are given below. The figures given were obtained as closely as practicable for "round numbers," by dividing the product of 1891 by the number of seconds in a year. For nickel, ozocerite, and iron-ore, the statistics of 1890 were used. The list begins with the minute cube of gold at the tip-top of the structure.

Substance.	Product per pound.	Cubic inches.
Gold	24 grains	0.006
Tin	$\frac{1}{16}$ ounce	0.016
Mica	15 grains	0.02
Nickel	$\frac{1}{8}$ ounce	0.02
Asbestos	$\frac{1}{16}$ ounce	0.036
Aluminum	$\frac{1}{16}$ ounce	0.04
Antimony	$\frac{1}{4}$ ounce	0.06
Bromine	$\frac{1}{8}$ ounce	0.06
Mercury	0.9 ounces	0.1
Ozocerite	$\frac{1}{8}$ ounce	0.1
Silver	1.848 ounces	0.34
Novacutite	$\frac{5}{8}$ ounce	0.4
Corundum	2.3 ounces	1.
Sulphur	1.2 ounces	1.
Chromic Iron Ore	4 ounces	1.7
Infusorial Earth	2.56 ounces	3.4
Fluorspar	10 ounces	5.8
Feldspar	11.4 ounces	7.
Borax	6.7 ounces	7.
Manganese-ore	1.66 pounds	10.4
Flint	1.06 pounds	11.4
Soapstone	1.05 pounds	12.1
Barytes	2.2 pounds	13.8
Zinc	5 pounds	20.
Mineral paints	3.33 pounds	22.
Copper	9.4 pounds	27.
Lead	12.8 pounds	29.8
Fibrous talc	3.33 pounds	33.4
Iron pyrites	8.5 pounds	46.7
Grindstone	5 pounds	64.
Slate	7 pounds	69.
Asphaltum	2.85 pounds	69.
Mineral waters	0.58 gallons	134.
Gypsum	13 pounds	166.
Marble	18 pounds	190.
Potters' clay	28 pounds	293.8
Phosphate rock	41.8 pounds	346.
Sandstone	48 pounds	622.
Salt	88 pounds	1140.5
		Cubic feet.
Cement	98 pounds	1.2
Granite	321 pounds	1.9
Iron-ore	1136 pounds	3.6
Petroleum	72 gallons	9.6
*Natural Gas	892 pounds	11.4
Limestone	1419 pounds	12.8
Anthracite	1.4 tons	31.
Bituminous coal	3.3 tons	96.

* Measured in its equivalent of cannel coal.

THE WORLD'S FAIR AND THE RAILROADS.

By H. G. Prout.

IT is too early to make a just estimate of the part taken by the railroads in the World's Fair. That estimate would include the public service of the railroads in transporting people and material to and from the Fair; the display made by the railroads of objects instructive as examples of skill in the mechanic arts and of growth in refined taste; and, finally, it would include a summing up of the effect of what the railroads did, upon the science and the art of railroading itself.

But we cannot yet find any precise measure of the public service, for we do not know how many World's Fair passengers the railroads carried. In the first place, the railroads have not made up either actual figures or comparative figures of the passenger travel during the World's Fair season; most of the published figures are more or less accurate guesses. In the second place, the passenger movement last summer would have been abnormally small but for the World's Fair. In comparing the passenger movement of this year with other years we shall compare a very dull season, plus the World's Fair travel, with average seasons; so our standard of measurement is shaky. Some time must pass before we see any effect of the World's Fair on design or construction of material or on the methods of operation. Therefore what I shall say must be mostly a statement of impressions rather than a record of demonstrable facts.

What the railroads did was to be seen from two points,—outside of Jackson Park and inside; and I have often thought that their work outside was vastly more important than their display inside the Park. They began with a subscription of about $1,850,000 to the stock and bonds of the Columbian Exposition. This was followed by preparations for the great passenger movement that was to be expected. Unfortunately, the railroads of the United States are not as a rule making money. Year by year the rates fall and the ratio of expenses to earnings rises, in spite of the skill and care with which their affairs are conducted; and so, year by year the returns on railroad property decline. This seems to be the law, and the end no man can tell. But in 1892 and the first months of 1893 the railroads were feeling the effects of foolish financial legislation as much as any other interest in the land, and the men who were managing those properties were face to face with the hard questions: How much are we justified in spending in preparing for the Fair? How shall we get the cash or credit for such improvements as seem justifiable? As a result of pinching times the preparations of the railroads were mostly in the purchase of locomotives and cars; little extra work was done on yards, tracks, and signals, except in two or three special cases.

As the time approached for the heavy travel more regular trains were put on all the railroads reaching Chicago, and running time was shortened. Thus we find an increase of more than 26 per cent. in the number of regular trains out of New York for Chicago, compared with the same month in 1892; and there were five trains running in 25 hours or less in 1893 against two trains in the former year. A similar increase of service, but relatively less in the number of trains and increase of speed, was made on the railroads reaching Chicago from the southwest, the west, and the northwest.

The most striking feature of this part of the preparation for World's Fair travel was the acceleration of speed between New York and Chicago. The distance is 912 miles by the Pennsylvania, 968 by the New York Central's shortest route, and 976 by the New York Central and the Michigan Central. Seven west-bound trains made this run in 26 hours or less, five in 25 hours or less, and one ran 968 miles, every day, in 20 hours. Altogether this was a magnificent and unequalled group of fast long-distance trains; and this 20-hour train was much the fastest train in the world making anywhere near the same distance. It made 48.4 miles an hour, including all stops, for almost 1000 miles.

Another striking incident of this same movement was the rapid lowering of records of high speeds, the climax being reached in May, when engine 999, of the New York Central and Hudson River road, ran a short distance at the rate of 102.8 miles an hour, hauling a train. The same engine is supposed to have made another run at 112.5 miles an hour; but this last cannot be accepted as a record.

Some of these fast trains have been taken off and the time of others has been lengthened; but the lessons remain. The railroads know, and the public knows, that a 20-hour service between the two greatest cities of the continent is practicable; that there are no mechanical difficulties in running it, day in and day out; that it is merely a matter of administration and finance. We may expect that with the return of prosperity and brisk travel 20-hour trains will be run on both of the great New York-Chicago roads.

The next stage in the development of transportation to the Fair was the establishment of the long-distance excursion trains, without sleeping cars, and with one fare for the round trip. This was an experiment and there were grave reasons against it. From the start it was doubtful if there would be any direct profit from these trains. The rate must be low and the advertising expenses high, for it was essential, if these trains were run at all, that they should be heavy and run full. These heavy extra trains, run in several sections, would interfere with other traffic and thus reduce earnings and add to cost of working; so the chance was that the direct profit would be more than absorbed by the indirect loss. Furthermore, the half-fare excursions would be sure to take some of the passengers who would otherwise go by regular trains and pay full fare; how many full fares would be lost, and how much entirely new travel would be created by the low rate, no one could even guess. But the railroad officer has no moral right to administer the property which the owners have entrusted to his care for any other purpose than to make money for those owners; it is none of his business to make "popular" experiments merely because they are popular.

Back of all these considerations was one which gave every responsible officer who was fit for his place more concern than all the rest together; that was the greatly increased danger. But the shopkeepers, the hotel-keepers, and all the speculators who had put up the prices of their own wares, the newspapers which had raised their advertising rates, the great mass who wished to travel cheap, and the friends of humanity who put the owners of railroad stocks in a class by themselves,—all these cried out without ceasing that the railroads were ruining the Fair. It is quite true, too, that there were some among the railroad officers who thought that they could make money by a great cheap-excursion movement.

In July the half-fare day-coach excursions were started. In numbers of passengers moved they were strikingly successful. They carried out of New York city only 25,000 people in all; but New York is probably the worst city in the Union to get excursionists from, proportionately to its population. A little reflection will disclose the psychological basis of this curious fact. From other towns, and from the farming districts, the day-coach excursions got immense loads. Trains that left New York in three sections with 500 passengers reached Chicago in eight sections with 2300 passengers. Compare these with some of the excursion trains out of Pittsburgh. For instance, on October 11 an excursion train left that city in nine sections, carrying 2571 passengers for Chicago, and taking up more on the way. On October 21 another train ran out of Pittsburgh in eight sections, with 3575 passengers. There appears to be no record of the number of people taken into Chicago by these two wonderful trains. It will be observed that the heavier of the two averaged 447 passengers to the section. A "section" is of course a complete train in itself, but the eight or nine sections are run on one time schedule, as one train, so far as the time-card goes. Now we have a record of a still more remarkable train of but one section. That ran out of Pittsburgh on August 16 and consisted of one engine, one baggage-car, and eighteen coaches, and carried 912 passengers. When one thinks of the awful consequences of wrecking such a train some of the dread that operating officers have of excursions may be understood.

It is too early to more than guess as to the profit of the excursion trains,—and indeed we shall never know it exactly, for reasons that I have suggested above. One general passenger agent, who was among those who urged the reduction of rates, is now sure that his road lost money by the excursion trains, and yet it had no accidents. Another, who resisted the movement, and wanted rates kept up, is sure that his road made money out of its very heavy excursion business.

I shall not attempt even a guess at the general increase of passenger movement during the World's Fair, for it might be very misleading. I will give only a few examples that will suggest the magnitude of the movement. The total of passengers out of New York city for Chicago, for the six months, was close to 137,000, and the increase over the same six months in 1892 was 357 per cent. That did not, however, give any approximate notion of the increase in the trunk-line territory, for many people went to New York from neighboring towns, and from Europe, to begin the journey. One of the trunk-lines estimates its increase in passengers carried, due to the World's Fair, at less than 1 per cent., not including in the comparison the commutation travel in either year. This is one of the great through lines from Chicago to New York, running through a rich country with many prosperous towns on its lines, and with numerous branches and tributary lines covering a great territory either side of its main stem. Its experience will at least suggest the effects produced in all the area outside of a circle with a radius of say 300 miles, of which Chicago is the center. Absolutely, a great many passengers moved toward Chicago, from all that vast outside area; relatively, the movement there was trifling, for it must be understood that we are dealing with immense figures. The passengers carried in the United States in 1892, by the steam railroads, leaving out the elevated railroads of New York, were about 576,000,000. Or for six months, we may say they were 288,000,000; an increase of only 1 per cent. would be 2,880,000 passengers.

As we approach Chicago the movement of the people increased. On one division of one of the trunk lines, being the link that begins 500 miles and ends 300 miles from Chicago, the through business increased 178 per cent., which means that the total passenger movement on that division increased more than 80 per cent. over the normal. That was enough to cause an average increase of about 56 per cent. in the number of through passenger trains. One need not have much familiarity with railroad working to realize that on a line already busy such an increase means an enormous addition to the work to be done by all hands. But it is only at Chicago itself that we get the really colossal figures. There we find that at one station alone,—that of the Chicago and Northwestern,—the number of passengers handled, in and out, in the six months was 7,859,000. The loaded cars, in and out, were 182,000; the trains run were 50,500. Unfortunately, the company has compiled no figures comparing this year with last. On "Chicago day," October 9, this company took in and out of the Wells-street station, 80,828 people, and on the three days, October 7–9, the aggregate was 205,228 people, in and out. The reader will understand that all of those people had to cross the city and get to and from the Fair by some other conveyance.

Of course the Illinois Central was more affected by the World's Fair than any other one of the great Chicago roads, and more than all of the rest of them put together. That road not only carried people to Chicago by its own lines from New Orleans, St. Louis, and Sioux City, but delivered to the Fair many of the passengers brought into the city by the other railroads and carried back and forth a never-ending stream of people living in the city itself. The opportunity was great and the management of the railroad met it with wisdom, courage, and high technical skill. Perhaps one result will be a long truce in the perpetual warfare that rages between this railroad and the people of Chicago.

The Illinois Central is said to have handled on all its Chicago trains,—that is, through trains, suburban trains, and special World's Fair trains,—in and out, a little over 19,000,000 passengers. That is Chicago business alone, be it observed. But in 1892 the total passenger business of the road, covering all its lines, was a little less than 12,000,000 passengers carried; or in half the year it was, say, 6,000,000. The increase in passengers moved must have been something more than 13,000,000, or 217 per cent. Of course the increase in passenger earnings will be nowhere near this, for the new business was very short trips at low rates. But as a feat of railroading it was magnificent. The company spent in preparation directly and indirectly over $2,000,000, not including its great new terminal station. I say directly and indirectly, for much the greater part of this expenditure is a permanent and valuable investment. The one item of raising the tracks for 2½ miles, over thirteen city streets, cost $1,260,000, and that permitted the running of express trains at high speeds, without stop, from the heart of Chicago to the Park entrances. The tracks were covered with an admirable system of block-signals, and special ticket-booths were provided, so that great crowds could be served with the least possible delay. Three hundred special cars were built, with cross-seats, and open sides, and a train of these cars carrying 1000 people could be stopped, emptied, and started again in thirty seconds. These trains alone handled nearly 900,000 people during the Fair, and it was done with astonishing speed, comfort, economy, and safety. Indeed, we are told that of the 19,000,000 passengers carried by the Illinois Central during the six months, not one was killed and but five were injured, and they were injured through their own carelessness. On the whole this performance, the preparation for it, and the results, made up one of the most valuable "exhibits" of the Fair, and one which adds to the glory of American railroading.

We will return for a moment to the general topic of the transportation of passengers to Chicago. What I have said of the increase in the numbers carried will give a wrong impression if we do not remember that much the greater part of this increase was concentrated in the last two months. That was what made the trouble, added to the danger, and reduced the profits. Up to the beginning of September the travel was but moderate, there was no discomfort, and there were no unusual accidents ; but in September and October the crowds moved, trains were overfilled, the delays were great, and there came an appalling succession of accidents which swept away profits and humiliated every American who is proud of his country. The record will stand to the everlasting discredit of our methods. That part of the story need not be retold ; it still burns in our minds. The misery of it is that it was foreseen from the beginning.

But how could it have been avoided ? First, by better signaling, more and better disciplined men, and closer supervision of all the details of operation ; second, by not trying to do so much work with the means at hand. The want of money came in to limit closely the first means. Very few of the railroads of the United States have yet felt able to work their lines under any block system, and in the year or two just preceding the World's Fair they were poorer than ever. Trained and disciplined men and competent officers are a question of time as well as of money : they cannot be picked up in the streets. So it seemed to be a physical and financial impossibility to prepare the railroads for a greatly increased passenger business,—that is, to prepare them to handle it with the same punctuality, comfort, and safety that are had with the normal traffic. The second precaution against accidents was, then, the one to be taken to discourage a congestion of traffic. The obvious way to do this was to reduce fares in the first weeks, while traffic was light, and to put them up later, and to let it be known from the start that they were to be put up ; for history taught that the last weeks would be the weeks of the greatest attendance and of the heaviest travel. The railroads did exactly the reverse. They kept rates up at first, while people needed to be stimulated to move, and reduced them later, when all the world had got ready to go. This to my mind is the greatest of all the lessons of the Fair for the railroads, if not for the public.

Finally, what has been the financial gain to the railroads from the World's Fair travel ? I began by saying that most of what I write here must be a statement of impressions rather than a record of demonstrable facts, but I will hazard the guess that to a few of the roads there has been considerable profit, to most of them none, to some of them actual loss.

We may conclude this part of the subject with the words of a railroad president who has been for thirty years an active operating officer : " I am very proud of the grand exhibition at Chicago.

I delight in its memories. Its realities were infinitely beyond my poor conception of its possibilities ; and dreadful and humiliating as is the record of railroad disaster, the handling and comfortable accommodation of that happy multitude deserves to rank among the marvels."

And so we come, rather late, to the second general division of my subject,—what the railroads did inside the Fair. My first impressions of the showing made by the railroads themselves and by those who have things to sell to the railroads was that, while there were some displays that were magnificent, many that were most pleasing to the esthetic sense and instructive to the mind, there were also many that were misleading to the uninformed, and some that were mere trash. As I saw more and learned more, this impression changed in degree, but not in kind. I thought more highly of the good exhibits and more leniently of the bad ones. I found that even the poorest of them interested, and perhaps instructed, many visitors, and there seemed to be few that ought not to have been admitted. The one great defect in this part of the Fair was the lack of coördination and completeness in collection and display. It was fragmentary. Many of its parts were admirable, some of them very remarkable; but the man who wished to study a subject through found the illustrations of it troublesome to follow up, and usually not at all comprehensive.

There were some grand exceptions to this. The collection made by the Baltimore and Ohio railroad was one of these exceptions. It was designed to show the historical development of the railroad, and the conception was carried out with something more than liberality of expenditure. Anybody can spend money; but the Baltimore and Ohio people did this with judgment and pains and learning ; and one of the most important events in the history of mankind was unrolled and illuminated before our eyes. A practical philosopher of our own country,—one who has not only thought but worked to great purpose,—once said that Sir Henry Bessemer had done more than all other recent forces to break down the aristocracy of England and to do away with class distinction. He meant that Bessemer's labors and discoveries had done this by lowering the cost of transportation. I am not quite sure that our philosopher did not exaggerate the importance of one element in this process, but there can be no doubt that one of the profoundest industrial revolutions that the world has ever known has taken place almost within our own generation and almost without our realizing it ; and it was the growth of the machinery by which this revolution had been made that the Baltimore and Ohio exhibit undertook to show. The success of its undertaking was great.

I should say that the next individual exhibit in importance was that of the Pennsylvania railroad, which was designed to show not the development of the railroad as a whole, but the development of one great, characteristic American system of railroads. And here again a liberal use of money was supplemented by a liberal use of sense and diligence, and the visitor could see here the whole history of the building of a great railroad company.

It would take too much space to mention the other meritorious exhibits of the various railroad companies. I have mentioned these two only because they were of such preëminent excellence ; but there were several others that were very fine. But there was one exhibit which, while not in the Transportation Department, and while classed as a concession rather than as an exhibit, was of such importance to the art of railroading that it should not be passed without mention. That was the installation of the "Intramural" electric railroad. The successful operation of that railroad was very suggestive to railroad-men, particularly to operating officers and to civil and mechanical engineers, and it is bound to have an effect on future practice. It showed some of the possibilities of electric traction in crowded cities, and has suggested to many minds a solution of what has within a few years come to be known everywhere as the rapid transit problem.

But let us return to the halls of the Transportation building. As a whole the display there of illustrations of American railroading was comprehensive enough and characteristic enough to be of real value to the student. Much of the material that was exhibited was not typical, but was fixed up for the occasion. Nevertheless, there was enough that was actually characteristic to give to foreigners and to Americans not familiar with the details of railroading, a just idea of American practice. The locomotives, for instance, that were exhibited were numerous and typical, so far as the United States goes, but the representation from abroad was disappointing. Still, the foreigner had a capital chance to learn about American locomotives, and the American had some opportunity to compare those with which he is familiar with those used abroad. The most casual observer could not fail to notice the great weight and the simplicity of the American locomotive, the extreme complication of the French, the tidy, thoroughly mechanical aspect of the English, and the simplicity (among the foreign engines) of the German locomotives. It was a great school for the younger mechanical engineers and locomotive-men of the railroads, and will doubtless bear valuable fruit, particularly in matters of design, construction, and finish of details.

We may say of the display of cars much the same that we have said of that of locomotives. The American showing was large and very handsome, and the foreign showing, while handsome in the specimens sent, was disappointing in quantity and variety. Nevertheless, here, too, the visitor had an opportunity to make some valuable comparative studies. He had an opportunity to learn that grace in form may be combined with the highest utility in the design of the most matter-of-fact details of a railroad car ; and I am inclined to think that one of the greatest benefits of this comparative exhibition will be in the development of a just taste in design. Our own designers had an opportunity to see what could be done with line and proportion and honest material honestly treated. They had a chance to see how vulgar our overloaded, embroidered, and bedizened cars often are, and what a poor substitute tawdry decoration is for competent and sincere work in elementary design. After all it was the old lesson that the ultimate triumph of any piece of human work, whether it is a picture, or a book, or a building, or the policy of a statesman, is simplicity.

It would be too great a task and would take too much of the space of THE ENGINEERING MAGAZINE to attempt to give an estimate of the value of the exhibits in all the multitudinous subdivisions of railroad organization. The showing of air-brakes, of signaling in various forms, of wheels, axles, brake-shoes, track, and all the thousand-and-one details which go to make up a railroad, was worth weeks of study. It is safe to say that many inventors, designers, constructors, and operating officers have moved up a step as the result of the Fair. Their future work will go on from a higher plane. Doubtless some general passenger agents have learned a lesson or two, and perhaps even the great public will have a more correct notion than it ever had before of what railroads ought and ought not to try to do. Altogether, this World's Fair was not an epoch in the science and art of railroading, nor should we expect a revolution as a consequence of it ; but it has been an immense stimulus to thousands of minds which are every day creating that science and developing that art.

DESIGNERS AND ORGANIZERS OF THE FAIR.

By Edward C. Shankland.

IN the summer of 1889, when each of several cities of the United States was striving for the honor of being chosen as the site of the World's Columbian Celebration, it was resolved by the city council of Chicago that that body, in connection with the mayor, should appoint "a committee of 100 citizens to take preliminary steps towards securing the location of the World's Fair in Chicago." Mayor Cregier decided that 100 was not enough, and at the next meeting of the Council presented a list of 256 names, which was promptly confirmed.

In August an executive committee of thirty-five was appointed out of this number. This committee immediately formed itself into a company known as the World's Exposition of 1892, to have a capital stock of $5,000,000, and applied for articles of incorporation under the laws of the State of Illinois. The signers of this application were Ferd. W. Peck, DeWitt C. Cregier, George Schneider, Anthony F. Seeberger, W. C. Seipp, John R. Waller, and E. Nelson Blake. About this time E. T. Jeffery, a well-known railroad-man, and Octave Chanute, an eminent civil-engineer, were sent to Paris to report on the exhibition there in progress. The next thing to be done was to raise the $5,000,000 of stock. The finance committee, of which Lyman J. Gage was chairman, worked hard and succeeded in raising $500,000, but after that subscriptions came in so slowly that the finance committee became alarmed. The whole matter was then put in the hands of Otto Young, who had expressed his belief the money could be raised—and his willingness to undertake the work. He formed a sub-finance committee, composed of himself, B. R. De Young, and D. K. Hill. Mr. De Young was soon succeeded by H. H. Kohlsaat. These three men devoted themselves night and day to their herculean task, and by January 9, the day on which Chicago was to plead her case before Congress, they had secured pledges for $5,000,000, and had won their cause. While Mr. Young and his associates deserve especial praise for their efforts, every one connected with the organization at this time devoted himself to it unselfishly, to the neglect of his own affairs. Mr. Ferd W. Peck worked mightily in the cause, as did Thomas B. Bryan, R. A. Waller, and Robert

Lindbloom, of the committee on agitation, and E. F. Cragin, secretary of all the committees.

On March 26, 1890, Congress—having in the meantime stipulated that Chicago should raise an additional $5,000,000, making a total of $10,000,000—passed a bill making Chicago the site for the World's Columbian Exposition. On April 4 a meeting of stockholders was held, and forty-five directors were elected. L. J. Gage was elected president, A. F. Seeberger, treasurer, and W. K. Ackerman, auditor. Benjamin Butterworth was the first secretary; later, H. O. Edmonds took his place. On April 9, 1890, a license of incorporation was received from the State legislature. In May a National Commission was appointed by President Harrison, composed of members from each State in the Union, and it elected Thomas W. Palmer president, and George R. Davis director-general. The duty of the National Commission, known as the World's Columbian Commission, was to handle the whole question of exhibits, and to deal with the foreign governments. The local directory, known as the World's Columbian Exposition, prepared the site and put up the buildings. This great work devolved directly upon the grounds and buildings committee, and the men who as members of this committee contributed so largely to the success of the Fair are E. T. Jeffery (chairman), L. J. Gage, H. B. Stone, C. H. Schwab, J. P. Ketchum, R. A. Waller, and A. W. Sawyer (secretary).

To show the commercial or business standing of the gentlemen in whose hands was placed the financial organization of the Fair, it may be mentioned that of the above list Mr. Peck is a large owner of real estate in Chicago; Mr. Seeberger is a wholesale hardware dealer; Mr. Seipp is a brewer; Mr. Gage is the president of the First National Bank of Chicago; Mr. Young is a merchant and the owner of much valuable real estate; Mr. Hill is a member of a clothing firm; Mr. Kohlsaat is the editor of the Chicago *Inter-Ocean*; Mr. R. A. Waller is a real-estate owner and a leading insurance-man; Mr. Ackerman is a past president of the Illinois Central railroad; and Mr. Stone, formerly a railroad president, is general manager of the Chicago Telephone Company.

The first question for the directory to settle related to the site. The north and west sides of the city each offered a site, and the south side two. Then the lake front had many supporters. Each site was warmly defended, and a vigorous fight ensued, which was finally ended by the selection of Jackson Park, with the lake-front as an entrance. On August 20, 1890, the grounds and buildings committee appointed F. L. Olmsted & Co. consulting landscape architects, and, on September 2, Burnham & Root as consulting architects, and A. Gottlieb as consulting engineer. In October Mr. Burnham was made chief of construction. The consulting landscape architects, the consulting architects, and the consulting engineer formed an advisory board, Mr. Burnham being chairman. This board at once started to work up a general plan of the Exposition, the directory giving them the number and size of the buildings required. From sketches made by H. S. Codman, Mr. Olmsted's partner, Mr. Root drew on brown paper, with a lead pencil, a rough sketch of the whole scheme. This was submitted to the World's Columbian Exposition, and adopted December 1, 1890.

Upon the approval of the World's Columbian Commission of the action of the World's Columbian Exposition, the order was given to proceed with the design. Then came up the question of the selection of the architects. Mr. Burnham insisted that there should be no competition, but that he should be allowed to select the men he deemed worthy from the whole country. This was finally adopted by the grounds and buildings committee in the face of strong opposition, and they authorized Mr. Burnham to select five architects outside of Chicago to design the five principal buildings around the Court of Honor. Later he was directed to choose five from Chicago to design the other buildings. This one act of Mr. Burnham, more than any other in its history, made the Fair an architectural and artistic success.

The list of architects chosen by Mr. Burnham, with the buildings as afterwards apportioned to them, follows: Richard M. Hunt, Administration building; Peabody & Stearns, Machinery Hall; McKim, Mead & White, Agricultural building; George B. Post, Manufactures and Liberal Arts; Van Brunt & Howe, Electricity; S. S. Beman, Mines and Mining; Adler & Sullivan, Transportation; Henry Ives Cobb, Fisheries; Burling & Whitehouse, Festival Hall; and Jenney & Mundie, Horticultural building.

These gentlemen, with the consulting board, and Augustus St. Gaudens, the sculptor, met on January 10 in Chicago and agreed on certain rulings as to heights and other conditions which should govern all the main buildings. Afterwards it was determined to select an architect for the Woman's building by means of a competition confined to women. Miss Sophia G. Hayden was awarded the first prize, and was employed as the architect of the building.

It was understood that the architects should not furnish any constructional plans, but that all of the construction should be designed by Mr. Burnham's staff. On February 20, 1890, the architects met again for consultation, each one having his sketches, which he submitted for the criticism of the others. It now became necessary for Mr. Burnham to organize his staff and to form an estimate of the work to be done. I cannot do better than quote from Mr. Burnham's report to the World's Columbian Exposition :

Roughly speaking it consisted of reclaiming nearly 700 acres of ground, only a small portion of which was improved, the remainder being in a state of nature, and covered with water and wild-oak ridges, and in twenty months converting it from a sedgy waste by the borders of an inland sea, into a site suitable in substance and decoration for an exposition of the industries and the entertainment by the republic of representatives of all the nations of the world. On its stately terraces a dozen palaces were to be built,—all of great extent and highest architectural importance,—these to be supplemented by 200 other structures, some of which were to be almost the size of the Exposition buildings themselves; great canals, basins, lagoons, and islands were to be formed ; extensive docks, bridges, and towers to be constructed. The standard of the entire work was to be kept up to a degree of excellence which should place it upon a level with the monuments of other ages. It meant, in short, that an organization must be quickly formed which should associate the ablest architects, landscape designers, painters, sculptors, and engineers of the country. Previous to this time it had not been possible to form a proper corps of expert men to handle the work. The opportunity for gaining honorable distinction, however, made the duty of choosing the men for the force comparatively easy, and in a very short time after the plans were finally adopted, the following were on the field of action, working with one object—the welfare of the great enterprise :

Charles B. Atwood, Designer in chief.
William Pretyman, Director of color.
E. G. Nourse, General engineer.
Frederick Sargent, Electrical engineer.
J. C. Slocum, Mechanical engineer.
W. S. MacHarg, Sanitary and water engineer.
John W. Alvord, Engineer of grades and surveys.
Ernest R. Graham, Assistant chief of construction.
Rudolph Ulrich, Landscape superintendent.
Dion Geraldine, General superintendent.
W. D. Richardson, Superintendent of exterior covering.
F. O. Cloyes, Chief draughtsman.

Later Mr. Slocum and Mr. Sargent resigned, and R. H. Pierce was made electrical engineer, and C. F. Foster mechanical engineer. In the summer of 1891 Mr. Gottlieb, chief engineer, resigned, and Edward C. Shankland took his place. W. H. Holcomb was made general manager of transportation, and E. G. Nourse became assistant general manager. Mr. Pretyman resigned in May, 1892, and Frank D. Millet became director of decoration. Colonel

Edmund Rice, U. S. A., took control of the guard in May, 1892. Marshal Edward Murphy took entire charge of the fire department in December, 1892. C. D. Arnold was made official photographer; Dr. John E. Owens, medical director, and F. J. Mulcahy, purchasing agent. Mr. Geraldine resigned in the fall of 1892. Later, upon the completion of his duties as superintendent of exterior covering, W. D. Richardson was made general superintendent of buildings.

To F. L. Olmsted & Co., and especially to Mr. Codman, who gave his personal attention to the work, belongs the credit for the general scheme and design. Mr. Codman died before the opening of the Fair, but he lived long enough to see his plans practically completed, and to know that the Exposition would be a grand success, and largely through his own efforts. Mr. Root died in January, 1891, shortly after his sketch had been adopted by the grounds and buildings committee, but his sketch has been largely followed and his genius has been felt throughout the enterprise.

Mr. Burnham needs no word of praise from me. His magnificent courage, his untiring energy, his loyalty to his staff, would have made a success of the enterprise had the obstacles been even greater than they were. He is the man who built the Fair, and the glory of his fame will but increase when the history of the Exposition comes to be written. His assistant, E. R. Graham, presided at the meeting of the staff each morning. His grasp of affairs was remarkable, and the amount of work done by him prodigious. M. B. Pickett, at first private secretary, afterwards secretary of works, by his ability, tact, and capacity, was of great assistance.

One of the earliest questions discussed was that of transportation. Upon it the location of the site largely depended. W. H. Holcomb, general manager of transportation, aided by E. G. Nourse, assistant general manager, solved successfully the very complicated problems which arose. It was also made Mr. Holcomb's duty to receive the exhibits from the railroads, and put them on the spaces allotted to them, and take care of the empty packing cases.

F. Sargent laid out the power-plant, and located the dynamos. He proposed the scheme for general electric distribution. This scheme consisted of an underground tunnel for running the wires connecting the several buildings, and a general distribution on the Intramural railway, and from the main subway, in small ducts, through which the wires were drawn. This was modified by running a subway of underground ducts to carry the wires originally intended to be put on the Intramural railway, as this was found not to be feasible.

Luther Steringer was retained by the Exposition as consulting electrical engineer on illumination, and to him belongs the credit for the coronas in the Manufactures and Liberal Arts building, for the design of the electric fountains, and for the interior illumination of the Administration building and the galleries of Fine Arts. Aside from this the whole credit for the successful installation of the vast electric plant used by the Exposition belongs to R. H. Pierce, electrical engineer. Only those on the grounds know how serious were the problems or how many were their complications.

C. F. Foster did not come to the service of the Exposition until within two-and-one-half months of the opening. Most engineers, looking over the ground when he took hold, and seeing the lamentably incomplete condition of the plant, would have refused the position, realizing the almost hopelessness of bringing order out of such chaos, but Mr. Foster did not hesitate. It kept him hard at work night and day, but he had the satisfaction of being eminently successful in his work, and the Power Plant of the Exposition is a monument to his skill and perseverance.

It was W. S. MacHarg's duty to design a system of water supply, sewerage, and drainage for the park, equal to a city of 250,000 inhabitants. Mr. MacHarg brought to his work a skill born of large experience. He used the Shone ejector system on a much larger scale than it ever had been done before, and his sewage cleansing works and crematory have been highly praised by eminent sanitary engineers who have visited the Fair.

When it was determined to make the exterior of all the buildings of staff, the construction department entered an entirely new field. Staff, or rather a stucco, had been used, but it had never been attempted before to completely cover the exterior of large wooden buildings with it. Mr. Burnham made a happy choice when he put W. D. Richardson, who had formerly been a contractor of large experience, in charge of this work. Experts who were called from Boston and New York could make no suggestions of value as to the methods to be employed, and Mr. Richardson had to determine for himself the best means for doing the work. That he succeeded will be questioned by no one who saw the buildings, with their statues, and the animal figures on the bridges and terraces, all constructed under Mr. Richardson's supervision.

The work done by J. W. Alvord in his department of surveys and grades, was admirable, and the completeness and accuracy of his work made it of the greatest value during the stormy period of construction. Mr. Geraldine can have no better praise than is afforded by the work done at the park during the time he was general superintendent.

The amount of work done by Mr. Cloyes and his force of architectural draughtsmen and the engineer draughtsmen who worked in conjunction with them, and in the wonderfully short time in which the plans were gotten out, can best be told from the record of contracts let. His department was organized April 1, 1891. By July 1 all the constructional and architectural plans had been made, and contracts let on the Administration, Horticultural, Manufactures and Liberal Arts, and Mines and Mining, Transportation, and Women's buildings, and the others followed rapidly.

In April, 1891, Mr. Gage declining a renomination, W. T. Baker was elected president. He was reëlected the next spring, resigning in August, 1892, on account of ill health, caused by the excessive labor he had done in this work. Mr. Baker was president practically during the whole period of construction, and he worked night and day for the success of the Exposition. H. N. Higinbotham succeeded him as president, and remained in office until the close of the Fair.

Each architect was allowed to select the sculptor for his building, and he, under the direction of the architect, and with Mr. St. Gaudens as advisor, designed the sculpture for that building. The list with their buildings is as follows :

Philip Martiny, Fine Arts and Agricultural buildings.
L. G. Mead, Main pediment, Agricultural building.
J. J. Boyle, Transportation building.
Karl Bitter, Administration building.
M. A. Waagen, Machinery Hall and Colonnade.
E. C. Potter and D. C. French, Peristyle.
Lorado Taft, Horticultural building.
Miss Alice Rideout, Woman's building.
A. P. Proctor and T. Baur, Lions on Art building.
A. P. Proctor and E. Kemys, Animals on bridges.
D. C. French, Statue of "The Republic."
Carl Rohl-Smith, Statue of Franklin.
J. Gelert, Figure of "Neptune" on rostral columns.
Frederick MacMonnies, MacMonnies fountain.
Augustus St. Gaudens, Statues of "Diana" and Columbus.

When Mr. Millet was made director of decoration he immediately called to his aid a distinguished coterie of artists : Reinhart, Simmonds, Reid, McEwen, Melchers, Blashfield, Cox, Shirlaw, Beckwith, Earle, Garnsey, Maynard, Sullivan, Dodge, Coleman, Weir, Louis Millet, and others. The Exposition owes much to Mr. Millet, and we of Mr. Burnham's staff have formed a friendship for him which time will not efface. He brought to us a mind trained in many channels, and a rare fund of practical common sense. He criticised us fearlessly, yet he was a generous true friend. He became one of us, and his zeal in the work was second to none. It was a liberal education to have been intimately associated with him.

I have stated that the World's Columbian Commission had in its charge the whole matter of securing and arranging the exhibits. Before the departments were organized a great deal of work in this line was done by Major Moses P. Handy, of the department of publicity and promotion. Walker Fearn, chief of the department of foreign affairs, conducted all the correspondence with foreign governments, and through his department was made all the assignment of space to foreigners.

As soon as Director-General Davis had organized his staff, composed of the chiefs of the different departments, each chief was given entire charge of securing the exhibits for his building, and assigning space for the same. W. I. Buchanan, chief of the department of agriculture, did all the work of getting together his very fine exhibit. He had charge also of the department of live stock, in which he was assisted by Mr. Garland, and the department of forestry, in which he had Mr. Evans as his assistant. To L. W. Robinson, chief of the department of machinery, belongs the credit of securing and installing the machinery exhibit. The incessant labor performed by F. J. V. Skiff, chief of the department of mines and mining, resulted in one of the most valuable and interesting exhibits on the grounds—that in the Mines building.

Dr. Allan Hornsby, assistant chief of the department of electricity, attended to all the details of securing the exhibits in his building, consulting with Chief Barrett in the general arrangement of the exhibits, and in negotiations with the more important exhibitors. Dr. Hornsby visited Europe in the interests of his department. James Allison, chief of the department of manufactures, aided by Frank Williams, collected the enormous exhibit in the Manufactures and Liberal Arts building. In the department of liberal arts Dr. Selim H. Peabody organized and planned the entire exhibit. Two bureaus of this department were installed in the Anthropological building, viz.: the bureau of charities and corrections, in charge of S. S. Rosenau, and the bureau of hygiene and sanitation, in charge of Dr. W. F. Brewer. Professor F. W. Putnam, chief of the department of ethnology and archæology, installed and arranged the exhibits in his department, although he had a number of distinguished assistants collecting for him in all parts of the world. Professor Putnam also collected the ethnographical exhibits in the Midway Plaisance and the cliff-dwellers and native American Indian exhibit at the South Pond.

William E. Curtis personally collected the very remarkable and interesting La Rabida exhibit. Mr. Curtis, as head of the Latin-American Bureau, represented the department of foreign affairs in the Madrid Exposition of 1892, for the purpose of securing the Columbus relics from Spain.

Willard A. Smith, chief of the department of transportation, had charge of the magnificent exhibit made in his building, being assisted by Lieutenant Baker, U. S. N., who had charge of the marine division. In the department of horticulture J. M. Samuels, the chief, was most fortunate in having for his assistant in charge of floriculture John Thorpe, to whom is due the credit for collecting and installing this exhibit. Mr. La Rue was in charge of the division of viticulture. Captain Collins had entire charge of the organizing and installing of all of the exhibits in the Fisheries building. Captain Collins was ably assisted by Mr. W. P. Seal.

Mrs. Potter Palmer, president of the board of lady managers, with the invaluable assistance of Mrs. Starkweather, collected the exhibit of woman's work in the Woman's building.

Professor Halsey C. Ives, assisted by Miss Sara Hallowell and Charles M. Kurtz, collected and installed the Fine Arts exhibit. Professor Ives visited Europe in the interest of his department.

The United States government exhibit, the finest ever made, and in many respects the most interesting and valuable of the whole Exposition, was collected and installed by the following:

Department of Agriculture: Edwin Willits, assistant secretary of the national department.

Department of State: S. A. Brown, chief clerk; W. E. Curtis, Bureau of American Republics; W. W. Rockhill, chief clerk.

Treasury Department: A. B. Nettleton, assistant secretary; F. A. Stocks, chief clerk.

War Department: Major Clifton Comly, U. S. A.; Captain Frederick Aytoun, U. S. A.; Captain A. H. Russell, U. S. A.

Navy Department: Commodore R. W. Meade, U. S. N.; Lieutenant Commander E. D. Taussig, U. S. N.

Post-Office Department: A. D. Hazen, third assistant postmaster general.

Department of the Interior: H. A. Taylor, commissioner of railroads; F. W. Clarke, geological survey.

Department of Justice: E. C. Foster, general agent; Cecil Clay, chief clerk.

Smithsonian Institution and National Museum: G. Brown Goode, assistant secretary.

United States Fish Commission: J. W. Collins, U. S. F. C.; Tarleton H. Bean, U. S. F. C.

Secretary and Executive Officer, F. T. Bickford.

The battleship *Illinois* was designed by F. W. Grogan, naval architect.

Respecting the character of men placed in charge of the various departments of the Fair, it may be said that Mr. Buchanan, in charge of agriculture, had been for four years chairman of the executive committee of the Sioux City Corn Palace; Mr. Robinson, chief of machinery, is an engineer in the United States Navy; Mr. Barrett, chief of electricity, is chief of the electrical department of the city of Chicago; Mr. Hornsby, the assistant chief, is a physician and an editorial writer; Mr. Smith, chief of transportation, is the editor of the Chicago *Railway Review;* Mr. Skiff, chief of mining, after many years in Western journalism became engaged in irrigation work; Mr. Allison, chief of the department of manufactures, brought to the work the experience gained in the Centennial Exposition of the Ohio Valley at Cincinnati in 1888; Professor Ives is the director of the art school in St. Louis; Mr. Thorp, of the horticultural department, lives in Flushing, N. Y., and has a world-wide fame as a florist.

All the concessions both in the Midway Plaisance and Jackson Park, before making contracts with the Expositions, had to be approved by the ways and means committee. When the great number of these concessions is considered, it will be seen that an immense amount of labor was performed by this committee, and H. N. Higinbotham (chairman), E. P. Butler, R. A. Waller, Andrew McNally, Adolph Nathan, M. W. Kirk, Washington Porter, and H. H. Hohlsaat devoted a great deal of time to this work, and the great diversity of the attractions, and the profits of the Exposition, show the good results of their efforts.

The limits of this article will not permit giving the names of all who deserve credit in this enterprise. The roster should include all: the engineers, the building superintendents, the draughtsmen, and the office force. Each one worked with all his might, not for self, but for the glory and success of the Fair.

COST AND INCOME OF THE GREAT FAIR.

By Anthony F. Seeberger.

THE magnitude of the World's Columbian Exposition has been a marvel to all visitors, and it will live in history as the most stupendous affair of the kind up to date. When it is considered that this great Exposition was the work of man, one must instinctively speculate at its cost. To say that it required the services of ten thousand men to prepare the grounds and erect the great buildings that have compelled the admiration of every beholder, would not be an accurate statement of the labor necessary to create this Exposition, because it would not include the unnumbered thousands of men and women who were engaged for months and years in preparing the exhibits which the buildings contained.

The approximate cost of erecting the various buildings and the necessary expense of management can be given, of course, and while these figures are colossal in amount, they would seem insignificant, if in an opposite column should appear the actual aggregate which has been expended in order to form the entire exhibition. It would be impossible to give the actual cost in time and money which this Exposition has required from its stockholders, promoters, and exhibitors, but we may omit this unledgered amount and still be overpowered with the figures which are available.

It was said that the great Paris exposition of 1889, which was claimed to have been,—and so acknowledged by everybody,—the very pinnacle of perfection in the way of an exhibition, cost about $8,000,000, and that it would be impossible for America to equal it. Able but pessimistic writers attempted to prove that the population of America, within a radius of say five hundred miles of any city, was not sufficient to support an Exposition of great magnitude, and that visitors from a great distance could not be expected in large numbers.

Premonitory symptoms of cholera, which was to some extent raging in the far east and traveling westward, were urged as a reason why it was not wise to attempt the exploiting of a great international exposition, which should in any way equal the great Paris success. It was claimed that if by any possibility the money could be raised and the people induced to come in any numbers from

COMPARATIVE STATISTICS OF GREAT EXHIBITIONS.

EXHIBITIONS.	Acres covered.	Length in days.	Number of exhibitors.	Number of visitors.	Estimated cost.	Total receipts.
London, 1851	21	144	17,000	6,039,195	$1,460,000	$2,530,000
Paris, 1855	24.5	200	23,954	5,152,330	1,700,000	1,280,000
London, 1862	....	171	28,653	6,225,000	2,300,000	2,942,410
Paris, 1867	37	117	50,216	10,200,000	4,000,000	2,103,675
Vienna, 1873	40	186	42,000	4,100,000	7,690,000	1,030,000
Philadelphia, 1876	60	....	30,863	9,910,916	8,500,000	3,800,000
Paris, 1878	60	194	32,000	16,032,725	....	2,531,650
Paris, 1889	1,373	183	60,000	32,354,111	11,000,000	8,380,000

abroad, they would bring with them the dreaded scourge of cholera, which would depopulate the city in which such an exposition was held, and the result would be a stupendous financial failure.

Notwithstanding the discouraging letters and telegrams from abroad, a corporation was formed to do the very thing which so many claimed could not be done, and now that the great Exposition has closed and the chiming bells have played their last tune, while the reverberations are still sounding in our ears, it is interesting to know that not a case of cholera has appeared, and the Exposition has been the greatest success of all the ages.

It is true that the money of the 30,000 stock-holders, who subscribed more than $6,000,000, and the additional $5,000,000 subscribed by the city of Chicago, cannot all be returned; but the contracted debts have been paid, and something will be returned to the patriotic citizens who so generously subcribed to the capital of the enterprise.

In order to have a proper conception of the magnitude of the World's Columbian Exposition, it will be necessary to mention a few facts in connection with previous expositions, that we may have some basis for comparison.

I am unable to vouch for the correctness of figures in the accompanying table, as I have no official reports at hand respecting the various exhibitions.

The total cash receipts of the World's Columbian Exposition, from all sources, and the disbursements, for all purposes, up to and including November 12, were:

Receipts	$33,290,065.58
Disbursements	31,117,353.79

During the month of May, 1893, there were 11,482 persons on the pay-rolls of the company, and their aggregate compensation was $387,499.89, not including about 7000 men employed by contractors.

The receipts and expenses for the six months from May 1 to October 31, inclusive, were:

Months.	Receipts.	Expenses.
May	$ 666,140.61	$593,757.20
June	1,647,644.44	630,595.20
July	1,967,194.84	598,319.97
August	2,337,856.25	569,798.12
September	3,169,938.92	537,566.92
October	4,402,467.35	610,000.00
Total	$14,141,242.41	$3,540,037.41

The average receipts per day during the Exposition period were $89,501.53. The average expenses per day, for the same period, were $18,380.59. The smallest attendance during the Exposition period was on May 5,—10,791, and the largest attendance was on "Chicago Day," October 9,—729,203. The total number of paid admissions for the Exposition period was 21,530,854.

RECEIPTS.

Balance from temporary organization		$ 4,252.64
Instalment receipts on stock		10,516,698.43
Interest on deposits		68,090.50
Received from sale of Souvenir coins	$1,094,144 78	
	1,435,000.00	2,529,144.78
Gate receipts		10,578,146.81
Received from concessionaires		3,384,016.23
Received for sale of bonds		4,444,500 00
Accrued interest on bonds		30,976.52
Miscellaneous receipts from sundry sources, comprising receipts for power and light, photographs, passes, badges, etc.		1,734,239.67
Total receipts		$33,290,065.58

Included in above total of disbursements are the following items, which should be specially mentioned:

Landscape gardening	$ 485,669.97
Landscape architecture	23,064.27

Dredging, filling, and excavating	$ 614,926.36
Coloring and decorating	382,544.84
Draughtmen's wages	178,159.94
Decorations	113,956.02
Electric plant	1,097,757.03
Interior docking	268,024.81
Grading and surveying	147,730.24
Piers and breakwaters	308,019.90
Roadways and sidewalks	346,246.92
Sculpture modeling	375,310.67
Statues	230,172.28
Superintending construction	188,548.28
Water and sewerage	926,030.77
Horses, wagons, harness, etc	38,170.82
Administration building	463,213.45
Agricultural building	659,294.61
Mines and Mining building	265,473.96
Horticultural building	296,399.93
Transportation building	554,041.20
Terminal railway-station	229,524.00
Grand fountains	122,500.00
Anthropological building	107,438.52
Music Hall, Casino and Peristyle	373,418.74
Art building	758,578.20
Art Institute	200,000.00
Fisheries building	234,733.29
Machinery Hall	1,225,515.98
Manufactures building	1,799,837.87
Public comfort	26,936.45
Grounds and buildings office	101,492.21
Convent of La Rabida	24,621.61
Shoe and Leather Trades building	93,243.76
Forestry building	82,708.59
Women's building	138,769.10
Electricity building	447,397.70
Elevation of the Illinois Central tracks	250,150.00
Furniture for buildings	108,552.39
Railway tracks	407,423.15
Exposition symphony orchestra	135,589.10
Fire protection	131,468.52
Foreign agents	118,045.35
Insurance	138,963.40
Installing exhibits	294,599.97
Operating power-plant	266,126.60
Police protection	885,558.90
Salaries of clerks	387,001.88
Salaries of officers	323,685.48
Salaries of musicians	128,674.85
Salaries of architects	133,830.23

It is proper in connection with a statement of this kind to mention the following appropriations made in the interest of the Exposition:

From Foreign governments..................	$6,571,529 00
Appropriations by different States of the Union..	6,020,850.00
Appropriations made by the United States government (not included in any of the above figures)	2,668,875 00
	$15,251,254.00

It would be a very interesting item for future reference if the actual amount expended by foreign and American exhibitors could be added to the above figures, but if any such estimate has been made, it has not come to my notice. Of course this will be approximately obtained.

ELECTRICITY

Conducted by Franklin L. Pope.

A DISTINGUISHED European electrical engineer, who availed himself of the opportunity afforded by the Columbian Exposition to visit the United States and to make a somewhat extended investigation of our electrical industries, has observed that there was really very little at the Fair which should be either novel or surprising to the American electrician, and that, for his own part, while he was much interested in what he saw there, he was far more surprised at the actual technical and industrial applications which he found in various places throughout the country. While this view of the matter is, in a broad sense, not altogether an incorrect one, yet certain exceptions thereto, and these by no means unimportant, must be admitted. The operation of nearly all the moving machinery outside of Machinery hall by means of electrical energy, involving the transmission and utilization in various ways of perhaps 5000 horse-power, furnished an object lesson in the way of the electrical distribution of power such as has never before been witnessed in the history of the world. The extraordinary flexibility and adaptiveness to every possible condition of which electrical energy is capable, was admirably exemplified by the comprehensive exhibit of the capacities of the Tesla polyphase system made by the Westinghouse company. On the other hand, the great rival of the Westinghouse, the General Electric Company, must be admitted to have especially distinguished itself in its practical demonstrations of the modern possibilities or rather actualities of electrical transportation. The Intramural electric railway,—the first thoroughly successful attempt, on a large scale, to adapt electricity to the onerous requirements of modern municipal rapid-transit,—was no less a revelation to the electrical engineer than to the general public, while the fleet of electric launches on the lagoons scored a success in behalf of the much discredited storage-battery, which was a good second to that achieved by the Intramural. Then there was the unique, but, as the event has demonstrated, thoroughly practicable system of transportation, best known as the "movable sidewalk," which certainly appeals to the mind of the progressive electrical engineer as an idea which is not unlikely to have an important bearing upon the problem which every year presses more and more for a solution—that of furnishing adequate means of conveyance from place to place of the enormous crowds of passengers who throng the sidewalks of our great cities, a congestion which rapidly increases from year to year, necessarily keeping pace with the multiplication of ten- and fifteen-story buildings, each containing a population equal to that of a moderate-sized country town.

OF course that abstract entity known as "the general public," having settled itself into the comfortable belief that there is nothing whatsoever, however difficult or impossible of accomplishment it may appear, which cannot readily be brought to pass by the aid of electricity, could scarcely be expected to grasp the significance of the really significant exhibits, but it was seemingly never tired of gazing with admiration and astonishment at the illuminations, the search-lights, the prismatic fountains, the scenic theater, and other like ingenious electrical diversions, which, although presenting for the most part but little of real novelty or interest to the professional mind, were nevertheless imposing from the mere fact of their number and profusion, and not infrequently from their completeness from an artistic point of view.

THE seventeen years which elapsed between the Centennial Exhibition of 1876 and the Columbian Exposition of 1893 form but a brief space in the industrial annals of the world, but, brief as it is, it practically covers the whole period of the existence of modern electrical development. A retrospective glance at the Centennial Exhibition reminds one that it was rather remarkable than otherwise for the meagerness of the exhibits illustrative of the progress, or even the then existing condition, of the electrical arts. There was a fairly good display of telegraphic apparatus, and of electric railway-signaling devices. The earliest American dynamo electric machine was on exhibition, and some more or less successful attempts at arc-lighting on a small scale were made, more as a matter of scientific curiosity than anything else. Nevertheless, there were present at the Centennial two exhibits which may fairly be said to have contained the promise and the potency of nearly everything that has served to excite the wonder and admiration of the countless visitors who thronged the vast spaces of the exhibition of 1893.

A GRAMME dynamo which had been imported from France was shown in operation at the Centennial, and the current derived from it was used to drive a motor which operated a small pump, thus furnishing a concrete illustration of the transmission of power by electricity. A certain well-known journal, which is not always quite so scientific in fact as it is in name, made the following comment upon this exhibit, which may be taken, perhaps, to fairly represent the attitude of the average practical man at that date: "As in this double conversion, of power into electricity and electricity into power, less power is obtained than is expended, the machine is apparently of no practical value, but is nevertheless interesting, as showing the relation existing between power and electricity." Only twelve years after the above was printed the writer stood beside a massive multipolar electric motor of 280 horse-power, which was smoothly and noiselessly driving the machinery of an extensive woolen manufactory at Derendingen, Switzerland, receiving its unseen power from a distant Alpine torrent through five copper wires each about the thickness of a common lead-pencil, and it was then and there that he was forcibly reminded of a certain dictum of Hosea Bigelow: "Don't never prophesy unless ye know."

THE other epoch-making exhibit referred to was tucked away in an obscure corner of the educational display of the State of Massachusetts. It consisted of a pair of crudely-made magneto-speaking telephones, by means of which, by dint of vociferous shouting, articulate speech could be transmitted through a wire, in a weak and shadowy way it is true, but still with sufficient volume to enable detached words and even short sentences, to be recognized by a careful and attentive listener. The general opinion of telegraphic experts, or at least of the very small number of them who were sufficiently interested in this new development of their art to hunt up the apparatus and examine it, was "on all fours," so to say, with that which has been above quoted in respect to the utility of electrical power-transmission. It certainly could not have entered into the wildest imaginings of any person present that the time would come, and that within seventeen years, when a business man, without getting out of his office chair in New York, could converse at a minute's notice with any one of more than 100,000 different persons, located almost anywhere between Boston and Milwaukee, and this without raising his voice above the ordinary conversational tone.

IT has been remarked, and not without a good share of truth, that electrical engineering is nine-tenths mechanical engineering. The great fact of the reflex influence of the former upon the latter has been most forcibly exemplified by a study of the mechanics of manufacturing and of transportation at the Fair. There have probably been more real advances made in the details of the construction of steam-engines, steam-boilers, and water-wheels, during the past seventeen years, than during any other equal period of time in the industrial history of the world. One of the wonders of the Centennial was the double-cylinder Corliss engine rated at 1400 horse-power, which was found to be amply sufficient to carry all the machinery of the exhibition. At the Columbian Exposition, engines of from 1000 to 1500 horse-power were almost too common to excite remark, while a single dynamo, used for supplying power for the Intramural railway, was directly coupled to the shaft of a 2000 horse-power Reynolds-Corliss engine, employed for that service alone, and easily capable of yielding 2500 horse-power. The advances which have been made in mere size are of far less importance than those tending to increased economy, efficiency, and accuracy of regulation, especially in high-speed and high-pressure engines. The newer designs of turbine wheels, too, typified more especially by the Hercules and the Pelton, still further serve to exemplify the recent improvements in prime-motors, which have largely been stimulated by the requirements of electrical engineering. The capacity of wheels of given diameter under low heads has been vastly augmented, not only without a loss, but with a decided gain in percentage of useful effect, while the high-pressure impact or hurdy-gurdy wheel of the Pacific slope has been developed into a compact and efficient motor of unique and valuable characteristics. Great advances have also been made in the important matter of the regulation of water-wheels for producing uniform speed under variable loads.

One of the most striking features of the Columbian electrical exhibit, viewed as a whole, was the simplicity and elegance which characterized the design of the large generators, motors, and switchboards. It would be difficult to imagine a greater contrast in this respect than that which appears between the angular and unredeemed ugliness of the early Gramme and Farmer-Wallace machines of 1876, which were in evidence in the historical exhibit, and the simple, flowing and graceful outlines of the massive electric-railway generators of the Westinghouse company. A notable advance in this direction has been apparent, during the past two or three years, all along the line, and from present indications it seems not unlikely that the characteristic American designs of heavy electrical machinery will for all future time bear as unmistakable an impress of the personality of George Westinghouse, as the typical American locomotive of to-day does of that of William Mason. The tasteful designs of the miscellaneous electrical apparatus of the Western Electric Company are also notable.

An observer with a practised mechanical eye could hardly have failed to have been impressed with the fact that the output of mechanical energy, either per square foot of floor space or per cubic foot of space in three dimensions, is always very much greater in the case of the electric dynamo or motor than in that of the steam-engine, and this is still more strikingly apparent if the boiler is also taken into account. Wherever a huge engine was coupled directly to the shaft of a dynamo, the fact that the steam-engine was two or three times as bulky and heavy as the dynamo could hardly escape notice. The remarkable compactness and simplicity of the electric motor is a feature which must ultimately tell heavily in its favor, when the art of distributing power from central-stations in large and busy cities, in which space is costly and valuable, becomes more general than it is at present.

The great vertical compound-condensing Reynolds-Corliss engine which formed the principal feature of the power-house of the Intramural railway at the Fair, made a most magnificent record. It was never once stopped during the period of the exhibition for repairs to the engine proper, and yet it propelled no less than thirteen trains of five heavily-loaded cars each, through the working hours of each day. The award committee watched the work ing of this engine on one occasion for twenty-three hours in succession, and satisfied themselves that while running at 100 revolutions per minute, its speed did not vary as much as 1 per cent., even when the gross load was suddenly reduced something like 50 per cent. A few years ago the construction of such an engine would have been scouted as an utter impossibility.

A PROMINENT civil engineer, in a recent communication to a technical journal, draws some interesting comparisons between the service of the Intramural railway of the Columbian Exposition and the Chicago Southside elevated system, operated by steam locomotives. He points out that for a given passenger capacity, the aggregate weight of the steam train is approximately double that of the electric train. The style of cars now in use, and the economy of putting as many cars in each train as can be started by the locomotive, induces the running of heavy trains at comparatively infrequent intervals, both for suburban and municipal traffic. The result is, that wherever the electric trolley-car, with its one-minute intervals and no-time schedule, competes with a steam line with trains fifteen or twenty minutes apart, it naturally takes the lion's share of the business. The opinion is expressed that the best practice in electric transportation will be found to be separate locomotives for long and infrequent trains, and electric motors attached to the trucks of passenger cars for light trains making frequent stoppages.

THE *Electrical Review* (London) expresses the opinion, in which most unprejudiced engineers will, we think, heartily coincide, that electrical engineering progress on both sides of the Atlantic is lamentably hindered by the senseless employment of so many different rates of frequency in alternating installations. No less than four different rates are in use in London, it seems, and the number in the United States is certainly greater rather than less. The *Review* believes that the losses at the higher frequencies must compel the electric companies to lower them at least one half, and that at no distant date. Indications are not wanting that the standard frequency in this country will ultimately be fixed, either by common consent or by the exigencies of commercial competition, at 7200 or less.

A WELL-KNOWN electrical engineer, as a contribution to the discussion which occasionally crops out in the technical journals in reference to the comparative cost of producing electricity by steam and by water-power, cites one instance of a water-power plant, the total cost of which, in round numbers, was $150,000, and which completely paid for itself within two years from the time it started. In the case of another plant, the cost of which was about $30,000, the working capacity was increased several fold, without any addition to the previous cost of operation. Every such plant, however, requires the most careful and intelligent preliminary study, before deciding upon the capacity and type of the machinery to be used. In figuring upon a plant of this kind, it must not be forgotten that the character and amount of the source of power is fixed by nature, while the amount of electrical energy which can be profitably utilized is also arbitrarily confined within certain narrow limits, so that the whole design must necessarily be a compromise between conflicting, if not absolutely antagonistic, conditions, a situation which challenges the skill and knowledge of the consulting engineer in an unusual degree.

THE first experimental trial in this country of electrical canal-boat propulsion has been made on the Erie canal at Brighton, a few miles east of Rochester, N. Y. The performance went off with great eclat, and was attended by a large concourse of distinguished personages, including the governor of the State. According to the enthusiastic reports furnished to the newspapers, the experiment was one of the most remarkable successes of the present age. A careful study of the conditions under which the trial was made lends color to the suspicion that this particular demonstration was exploited rather for advertising purposes than as the inception of a bona fide business undertaking. No electrical engineer, so far as we are aware, ever entertained any doubt that an electric motor is capable of propelling a canal-boat as rapidly, as economically, and with as little disturbance of the water as a steam-engine, if not more so. The whole problem, from a technical point of view, appears to consist in getting the current from the trolley-wire to the boat, and on this vital point the results of the "official" trial shed no light whatsoever. The devices used appear from the descriptions to have a makeshift adaptation of ordinary overhead street-railway apparatus, and were of a type which will, we venture to predict, be found wholly unsuitable for actual canal service. While no doubt need be entertained of the ultimate success of the scheme, it is difficult to understand why the working details might not have been elaborated at least to a sufficient extent to afford a real demonstration of the prospective merits of the system, before bringing it before the public with so great a flourish of trumpets.

THE winding and setting of a good-sized tower clock of the time-honored pattern is by no means a small job, inasmuch as the raising of a ton or so of dead weight to the top of a high tower once a week, is necessarily a work of time as well as of labor. All this drudgery, it appears, is henceforth to be performed by the ubiquitous electric motor. A new clock recently placed in the building of the Waterbury Clock Company, in the thriving Connecticut city of the same name, is not more than one-fourth the weight of a tower clock of the ordinary type having dials of equal diameter, and the whole machinery is operated by electric motors supplied with current from a sal-ammoniac battery of ten cells, which will run for a year or two without renewal. The great saving in actual power required to propel the clock largely results from the fact that the electric force is applied directly to the point where needed, without the intervention of the complex mechanism essential in weight-clocks of the ordinary type.

IN the construction of overhead lines for the conveyance of currents of high potential for electric lighting and power service, the greater part of the experience which has been gained during the past fifty years in the construction of telegraphic lines has apparently been altogether ignored. The ultimate results of this policy will be found to be eminently unsatisfactory. The early builders of electric-light lines simply copied in an unintelligent way the existing construction of the principal telegraph companies, using the same rickety ill-fastened cross-arms, weak wooden pins, and cheap glass insulators, that had been found barely tolerable for the low tension currents and light wires of the telegraphic service, for the heavy copper rods and high tension currents of the arc-lighting service. The mechanical features of this construction have been improved by the electric-railway constructors, whose more recent lines are doubtless sufficiently strong, although the conditions of insulation still leave much to be desired. As for the power lines, the glass insulator has been enlarged and strengthened, and so has its wooden pin, and in some few cases an inner cup for insulating oil has been added to the former. The only really serviceable and trustworthy insulator for a line for electric light and power service is the genuine vitrified porcelain used in the telegraphic service of Continental Europe, mounted on a strong wrought iron pin or bracket, and preferably supplied with an internal oil cup. The miserable clay imitations of domestic manufacture, which are sold under the name of porcelain insulators would for the most part not be worth putting up even if they were given away. There ought to be a thorough reform instituted in this country in the way of electric line construction. This department seems to be a favorite field for the operations of the particular class of economists who save at the spigot while wasting at the bung-hole.

ARCHITECTURE

Conducted by Barr Ferree.

ARCHITECTURE is the only art, profession, business, trade, occupation, industry in the world in which a man who knows nothing about it, who has failed in it, who has no ideas about it, can succeed. We trust there will be no undue rush to enter a profession in which the greatest prize can be obtained with the limited intellectual equipment indicated in these words. Neither would we imply that architects are not thinking people, or that hard-working, wise architects do not achieve success. Our opening statement, in fact, needs only to be made, to have its truth at once recognized. Why is any one a successful architect? Because he designs well, knows how to make a plan, has a keen artistic insight and sensibility, is a good draftsman, is entirely up in all the questions and problems presented by his profession? Not at all. An architect is successful if he commands a good practice, and he can command a good practice only by his personal connections, the friends he has, the confidence with which he can inspire his friends and acquaintances. This is the reason of success in architecture as it is now practised. There is no secret in it. We almost feel that an apology is necessary for introducing here anything so well known; but it is good, sometimes, to review thoroughly familiar facts. An unsuccessful lawyer cannot "succeed," no more can a poor doctor. No one, however close the connection, will give an important legal case to a lawyer for whom he has no respect, whose knowledge of law he feels to be inaccurate, and whom he knows will be an impediment instead of a tower of strength. Neither will one call in a physician to perform a delicate operation, or even for an ordinary case, simply because he knows him to be a good fellow. The poor lawyer, the poor doctor, the poor business man must all go to the wall if they cannot give evidence of ability to perform their respective tasks. It is not so with the architect. He may buy artistic skill, employ the most expensive and wisest engineers, and the most ready draftsmen. There is no limit to the special intelligence he may have and make his own if he wishes to obtain it. His own part need consist in nothing but his ability to hustle and get "jobs," and with this he may be well content. Knowledge of architecture, experience, artistic feeling, the architectural spirit, ability to design, all these, fundamental and elementary as they may seem, need have nothing to do with his success.

PEOPLE do not go to an architect because they think his work is good, or because they realize the power of his genius, as they realize the power of a painter or a sculptor, perhaps. As a rule people themselves know nothing about architecture, and so many bad things are done nowadays that the public taste is fairly educated on bad things. A very high building passes, popularly, as very high art, and the highest building of all, as likely as not, as the finest thing in the world. If an architect has had many jobs, and especially large jobs,—if his name readily occurs to one as an architect when one thinks of building,—he is forthwith commissioned to design a building which the projector and owner may be quite incapable of appreciating. Eminence did it you know, and apparently there is a power in Eminence's name. In this case professional activity brings the architect business, but it is only professional activity; professional ability, which is the measure of success in every other calling under the sun, has absolutely nothing whatever to do with it. All this is unpleasant, but is it not true? These discouraging conditions exist all along the line. They influence the architect's entire career. They discourage excellence of work, since it is not excellence that brings success, but activity. It is the crowded office, the immense drafting-room, the busy partners, the fuss, the drive, the turmoil that mark the busy architect. In many instances, the work is so divided up, so differentiated and distributed, that one man does the plan while another makes a façade that ultimately is to fit the other fellow's plan. An architect, moreover, can get rich only by increasing his practice. Unlike the painter or the sculptor, with whom, indeed, he has no relation or connection, he does not put up the price of his wares with increasing fame. Even the poor literary worker may do this; the successful maker of mint-juleps and of cocktails, the manufacturer of trousers, the scavenger, may each and all put up their prices, but the architect remains at one level, deals out good and bad at the same price, the product of his mature mind and of his student portfolios perhaps. All are treated alike, and thus it happens that architecture is a profession,—or an art, if you will, in which a man who knows nothing about it, who may not be fitted for it, who may not even like it, may achieve a lasting and gigantic success.

ARCHITECTURE is the art of solving practical problems, many of which have no connection, artistically or otherwise, with building, but all of which influence the artistic form of the structure, and all of which must be considered in any rational design. All design, and especially all modern design, is far from being rational. One need but to look through the streets with which he is familiar to meet the most amazing designs, the most astonishing contortions of the building art, the most surprising combinations of things well enough in themselves, but utterly absurd in unexpected and unappropriate places. It is unfortunate and unpleasant that such things should be, for a building—especially a large and costly one—is not a thing to be taken down because its art is bad. But a study of these unfortunate works of architecture is useful in pointing the meaning of the definition with which we have begun. The most conspicuous fault of current work is its ignoring of the rational An architect is a thinking man, and with an artistic architect a building is a product of his thought. It must, therefore, be rational. Yet in multitudes of instances it is not. This need not be demonstrated, because the examples of it are so numerous and so evident. Nor need the question be argued and a decision obtained from theoretical principles only. Of all the artistic things men do architecture most depends upon rationality as a basis. And this is simply an expression of the conditions and limitations under which it has developed. It is true that in the golden days of the historic styles architecture was concerned only with the solution of a few problems of comparative simplicity. In the present day we have no historic style to work in,—we can, unfortunately, take any style, and even maltreat that if we will,—and we have a multitude of problems. Yet this multiplicity, this complexity, this diversity is itself a fresh source, if it were needed, of rationality. The more complicated the problems, the more diffuse and difficult the conditions, the greater the need for rational treatment, the more the architect must think, the more refined and intellectual must his work become. But Greek architecture was wholly intellectual and wholly artistic. These two qualities are properly strongly united by the closest of ties.

THE New Zealander, if he ever stands upon the ruins of London bridge, will see no more amazing sights, will find no more profitable food to ponder over and write up on his return to his antipodal home, than every New Yorker may now see and ponder over in the structures surrounding the City Hall park. A large open space in a crowded city is naturally a favorite building site. Nowhere else do the buildings show to better advantage, nowhere else are there greater opportunities for the exercise of architectural talent, nowhere else are failures more conspicuous. This latter fact, indeed, does not make an open place more desirable for building, but it is one of the misfortunes the general public must suffer from when once the architectural innovator gets a foothold. The streets surrounding New York's City Hall park have long since been favorite ones for important buildings. The newspapers—those shining lines of civilization and of culture—have long since preëmpted Park row. The Post-office cuts off one end; the opposite side, Chambers street, is somewhat hidden by the Court House. Broadway alone, until the present year, has suffered no great change. But already this belongs to the past. The innovator has arrived, and with him a series of buildings, not one of which has any artistic reason for existing. What a spectacle greets the bootblack as, seated on the reverse side of his place of business, he awaits the morning customer at the Murray-street entrance. Across Park row is the marvelous dome of the Pulitzer building, that greatest of all architectural pyschological curiosities, with further off the *Tribune* and its tower, which the bootblack surely does not suspect to have been made by an architect of eminence. Further along is the *Times*, the best of the lot, perhaps, and certainly affording an agreeable contrast to the Potter "pile." Then, if our small Italian will turn his place of business and himself around and look up Broadway, he will see the just-finished Mutual Reserve building, further down the extraordinary chimney-with-a-hat-on-it front of the Shoe and Leather Bank. Then the new white marble front of the Home Insurance Company, striving to go up, though held down by many horizontal lines, and next to it the structure with an impossible arch, and various other idiosyncracies recently put up by the Postal Telegraph company. Shall we ask our Italian what he thinks of these? Perhaps he does not think, revolving there upon his place of business. There are such people, there must be, else how could these things be?

"WHAT Order do you call the first story?" said the friend to the architect who was showing him his recently completed building.

"That's the Doric!" replied the architect.

"And what do you call the second story?"

"That's the Ionic!"

"And the third?"

"That's the Corinthian!"

"And now tell me what's the thing up on the top?" anxiously inquired the friend.

"Oh," said the architect, "that's the Order of the committee!"

This ancient yarn is introduced into a collection of articles on the architecture of the Fair by Philadelphia architects, published not long since in one of the Philadelphia daily papers, and is contributed by Mr. Frank Furness. The articles are accompanied by a series of photographs of the contributing gentlemen representing the most woe-begone people we have met with for some time. We do not know why one's written remarks are more to the point when embellished with an accompanying photograph, but it is not often that the results are so disastrous as in the present instance. Mr. Furness's remarks express a great truth and a great fallacy. The ignorance of the general public, and even of that part of it which, for business or other reasons, is concerned directly with architecture, is truly amazing. The most extraordinary things are being erected by people who know nothing about architecture, but who imagine that the more amazing the structures they build the better art they are getting for their money and the better they are furthering the interests of architecture. Incidentally it may be remarked that, were it not for this circumstance, many architects would be unable to make a living in their profession. Of course Mr. Furness has no notion of teaching such a lesson as that, but in condemning the public it is well to keep in mind that the architects who do extraordinary things are only able to do them with ignorant clients, who encourage them in their making of monstrosities and help along the worst interests of the profession as best they may. This is the great truth Mr. Furness's anecdote teaches, unpleasant as it may be in its entirety to the architect.

THE fallacy is implied. There is no reason why architectural knowledge should be limited to the architects. Grant, if you will, they are the leaders in architectural movements; leadership does not imply exclusive and copyrighted rights of knowledge. The contempt with which architects sometimes look upon the public is most unkind and unnecessary, and does a great deal in nourishing the contempt which is becoming chronic with these two great classes, which could help each other so much if they would. The truth is that architects, as a class, do not appreciate the duties they owe the public as professional men. Immediate advantages and quick personal returns are more likely to influence the architect in deciding a course of action than broad questions of policy that might bring no returns for years to come. The generally inchoate condition of architectural societies, of which the American Institute is itself a notable instance, is quite sufficient proof of this state of affairs. The architect, existing as he does solely at the convenience of the public, being a wholly useless member of society alone and by himself, apart from the public, depending upon the public for opportunities to exercise his talent, to display his ideas, to make manifest his incompetence, if he be incompetent, owes the public a debt of professional knowledge he has not yet begun to pay. If the public knows nothing of architecture, save what it gains from the inspection of contemporary monuments, the architects have only themselves to thank for it if it insists, once in a while, on an Order of its own being placed on top of the classic Orders. It knows no better, poor thing; how could it think this proceeding wrong, especially when, as likely as not, the adjoining structure has an architect's Order of amazing style and form? Men in all branches of trade are constantly spending money that actually goes to the general betterment of their industry, knowing full well that in the end it will be repaid to them many-fold. One of the shrewdest advertisements ever inflicted upon a long-suffering public was the simple name of the manufacturer of the goods, without a hint of what he was advertising or how it was to be used. Naturally curiosity was excited, and when the product was finally announced it had a widespread celebrity it could have had by no other means. Architects cannot do just this thing, but they can help the diffusion of the true principles of their art among the public in a useful and beneficent manner if they will but set about doing it. The architects are really to blame for the architectural idiosyncracies they so much deplore.

HAVE you seen the Columbus Memorial building in Chicago? While it is not, in itself, worth a journey of a thousand miles, it is the most amazing product of the Columbian year in the City of the Fair. Located at the junction of two principal thoroughfares, it has the unfortunate advantage of being seen by all men, though such is the state of architectural appreciation that it may not be judged by all as it should be. It occupies a large and generous site, and the architect was not hampered, apparently, in this respect by the exacting conditions that spoil many a commercial building before it is erected. It begins with a basement or base in two stories that, appropriately enough, are given up to stores. It starts out therefore with the appearance of a brick building elevated on a glass base. The building proper really begins with the third floor. But the makers thereof were timid men: they could not build higher than a single floor before they must needs put in a string course, for no other apparent reason than to suggest that it was necessary to pause here for further thought. Emboldened by the success that attended their efforts thus far, they piled up two additional stories, sufficiently unobjectionable in themselves, only to stop again with a cornice of considerable width. Here, it may be presumed, the basement of the building came to an end, for otherwise there was no reason for running the cornice around the structure, though truly a three-story brick basement on a two-story glass sub-basement is a combination the like of which is not frequently met with even in this day of strange doings. Then comes a great spurt of ideas: five stories without a horizontal line, the windows being enclosed by pieces of walls—they are not true piers—ending in flat arches. At this point it was apparently judged necessary to begin to get to the end, and accordingly a single story of new design is built with a string course below and a cornice above. But this was not high enough and another single story was built, crowned by a wide cornice which marks the conclusion of the lower portion of the building. A simple cornice would never do for so complex a structure, and another single story is built over this, and, over it, again, in the center of the two fronts, a two-story gable, ending in a circular pediment. Meanwhile it should be pointed out that immediately over the glass basement the building breaks out on the corners into bow-windows which are continued to the top. These are not put-on bow-windows, mark you, but integral parts of the wall, so that the whole building exhibits a rich picturesqueness of outline that has seldom been surpassed, but which is surpassed in this very edifice by an octagonal tower on the corner ending in a dinner-bell dome that finely assists in breaking up the sky-line. This latter end is further helped by copper eagles and other ornaments on the gables that add very much to the spread-eagleism of the structure, as they were doubtless intended to do. Finally the general variety is concluded by the use of copper cornices, making the whole one of the most marvelous combinations of glass and brick and copper now visible on the face of the earth. It is a wonderful building done in a wonderful manner, and one which words alone quite fail in describing. Fortunately Chicago has other memorials of the Fair than this, but it is a pity the memory of its greatest success should be associated in any manner with this piece of architecture.

It is a somewhat significant fact that, while the architecture of the World's Columbian Exposition was admitted on all hands to be its most distinguishing features, the magazines and papers which are now printing backward glances at it, summary reviews and criticisms of all sorts, kinds, and conditions, have not included a single architectural writer among their contributors. Literary men without number have expatiated on the splendor of the architecture, have told us how great it was and how they were impressed by it, but not one of these people has any architectural standing. Most of them, in fact, know absolutely nothing about architecture, but imagine that, because certain structures seem to them good, they are quite competent to instruct others who know less than they do about them. A more flagrant case of the blind leading the blind it would be difficult to find. Of course it is impossible to stop people from writing on architecture if they think it their vocation to do so, and there would be no great harm done if their opinions were properly discounted. But the views of a literary man of wide reputation on any subject are apt to have an enormous vogue among the rabble simply because the name attached to them is familiar. There has been a vast deal of undignified writing about the Exposition and its buildings, and most of it has come from people whose knowledge of architecture is nothing at all. This procedure has done more than anything else to discount the real value of the Fair abroad. But in the end it has been a more serious reflection upon architects than any special loss to the world at large. Architects are apt to be biased folk and are fond of looking at their art through their own special stylistic spectacles. This in itself is so perfectly natural that it is difficult to find fault with it. Meanwhile every man and woman who can get into print is engaged in telling the world that the architecture of the Fair was its strongest point, congratulating the American people that they produced it, congratulating themselves that they saw it, congratulating the public that it is able to read their views.

RAILWAYS

Conducted by Thomas L. Greene.

IN considering the question of the proper charge of certain classes of improvements,—whether to operating expenses or to capital account,—it was stated a month ago that a railway was valuable only for the purposes of transportation. It differs in this respect from a parcel of ordinary real estate. A house, if sold under foreclosure, may be bought by some one in a line of trade different from that of the mortgagor. The mortgagee thus really relies upon the whole community for the safety of his loan. But a railway plant costing, say, $50,000 per mile, is worth but a small fraction of that cost except as a roadway for trains. Hence the reliance of the owner of a railway bond is in reality not upon the real estate, considered as such, but upon the earning power of the company as a carrier of traffic for hire. In discussing receiverships we have already seen that a mortgage upon a railway cannot be foreclosed and the assets divided, because public policy demands that a railway shall be kept running. The same conclusion is arrived at also as a matter of finance, because bondholders would get very little indeed if the right of way were to be sold as land to the adjoining farmers.

THE practical result of all this is that the strong language in which railway mortgages are drawn does not mean all it says, and that the holder of bonds is in great measure dependent for his money on the success of the railway in its business as a common carrier. From this conflict between legalities and facts arose our American system of receiverships and reorganizations, which keep up the fiction of an absolute lien while practically allowing a readjustment of capitalization to correspond with the real earning power. Our large systems are usually made up of a number of smaller lines originally independent and having their own bonds. Then we have bonds on terminal properties, bonds on divisions, and, last of all, "blanket" bonds, covering everything, but subject to the prior liens. When such a system finds itself over-capitalized and compelled to ask for readjustment, the task is complicated. The first thing to ascertain is the minimum of net earnings in a bad year. The fixed charges must then be cut down to this sum. Prior bonds on valuable portions of the road cannot be disturbed, so the losses usually fall on the division and blanket mortgages, with perhaps an assessment on the stock with the alternative of forfeiture. These losses must be adjusted by competent hands in proportion to the real value of the respective mortgaged properties to the system as a whole. The majority of the bondholders usually accept the plan if fair, the wording of their mortgages to the contrary notwithstanding; the minority by a transfer of title to a new company may find their opposition futile.

But American railways are judged not merely by their present earning power, but by the possibilities of the future. It is generally considered inequitable in a reorganization to cut down the principal and interest of bonds because of present depression, without giving the losers some evidence of their claim upon a possible increase of earnings. This evidence may be in the form of income bonds,—with interest payable only if earned,—or of preferred stock. In either case the security would represent deferred claims upon the company. For a number of years income bonds were favorites. The old idea of the sacredness of a "bond" still lingered and financial houses profited by the feeling. Nevertheless an income bond should have no place in carefully-considered plans. It is a contradiction in terms to speak of a bond on which payments are contingent. There can be, broadly speaking, but two classes interested in a railway or other company—creditors and partners. A bond whose obligations must be met under certain penalties makes its holder a creditor of the company. That creditor has loaned his money at a fixed rate of interest, with the plant itself as security. The fluctuations in the profits do not concern him unless his security becomes imperilled. On the other hand, stockholders are not creditors of the company, but partners in the enterprise. If the profits are large, they get them: if no profits at all appear, they suffer, but without redress upon the property. When, therefore, a bondholder for any reason accepts an income bond for part of his claim, he really changes his position. He is now dependent upon the fluctuating success of the company and in so far is a partner in the business. It confuses the real status in the mind to still call his deferred claim a "bond."

THE Atchison reorganization was highly successful. Holders of old bonds exchanged them for new general bonds and income bonds. In a few years the defect of the reorganization—unnoticed at the time—appeared. No provision had been made for fresh capital, while no road—particularly at the west—could stand still without improvements. When, however, the management began to consider the question of raising this new money, the income bonds stood right in the way. If the deferred claims had been turned into stock, the difficulty would not have occurred. As it was, no new bond could be in terms put ahead of the incomes. The only alternative therefore was the creation of a new mortgage into which the income bonds could be converted on terms favorable to them, and which should also arrange for other bonds which could be sold to the public. Thus, by the oversight of the reorganizers in a plan otherwise of the highest order and which proved a model for other companies, new bonds had to be put upon the property bearing fixed obligations under penalties of foreclosure, whereas the original intention was that only the general bonds should be an absolute yearly charge while all other payments should be optional and conditioned upon the varying prosperity. Experience, as well as true theories of finance, demands that contingent claims upon future profits should be represented by preferred stock, and not by income or preference "bonds."

IT is in this way that most of the American preferred stocks have arisen. They represent in most cases a cutting down of some old obligation and are therefore entitled to consideration. This consideration they usually get, for most of them are to receive good dividends befere the common shares obtain any return. From this circumstance of conceded priority there has grown up a sentiment that preferred shares are in effect bonds, thus applying to them something of the claim which we have discussed regarding income or preference bonds. It would be needless to say that these extravagant claims regarding preferred stocks should have no weight, were it not that at times efforts are made to insist upon them. The St. Louis and San Francisco first preferred stockholders were entitled to 7 per cent. per annum, and when dividends were withheld tried to enforce their demand in a suit. As we have before remarked, all shareholders are partners, and one class, even though granted priority, could not force from the other class or from the business what had not been earned. So far was this claim for priority carried that in some instances mortgages were given to secure the preferred stock's dividends. The St. Louis, Alton and Terre Haute has issued a dividend mortgage for this purpose. A case came up in an Ohio court which involved the validity of a mortgage given to preferred shareholders, the court deciding against the bonds.

A QUESTION of ethics in finance of greater difficulty is raised when we consider the cases wherein preferred stocks are to receive high dividends in perpetuity. A railway running out of Chicago two decades ago made the dividends on its preferred shares the same as the interest on its bonds then outstanding—7 per cent., which was the usual rate of interest on money at the time. The bonds had also the unusual feature that at any time they could be converted into preferred stock. Several millions of dollars of maturing bonds have already been exchanged and about $24,000,000 of additional bonds, maturing within ten years, doubtless will be so converted into preferred shares. Practically this arrangement continues to those maturing bonds a perpetual interest or dividend payment of 7 per cent., before the common shares receive anything. The rate of interest on first-class security has fallen from 7 to less than 5 per cent. The company could undoubtedly renew the expiring bonds at 5 per cent. or under, so that a large saving—amounting to nearly 2 per cent. on the common stock—could have been had, if none of the old bonds had been convertible. Concurrently with the fall in the rate of interest, the net earnings of all railways have greatly decreased in proportion to the volume of traffic, while capitalization is increasing. The advantages given to these preferred shareholders twenty years ago was equitable, but now it bears inequitably upon the common stock. The theory of the preference undoubtedly is that the favored shares shall have the first claim to an average return. There is no evidence that a payment much beyond the common interest on money was ever intended. This brings up what we have just called a question of much difficulty in the ethics and practice of corporation finance; namely, whether it is right ever to change a contract which compels continued payments indefinitely, when the circumstances under which the contract was first made have been materially modified. No machinery at present exists for solving this problem.

THE perennial puzzles of the railway-rate question are again exemplified in a case decided by the United States Court for the Virginia circuit. The Delaware Grange complained of the New York, Philadelphia and Norfolk (a part of the Pennsylvania system) because of its charges on farm truck from that peninsula to Philadelphia. The commission decided against the road, which declined to obey the order. The court dismissed the case when the commission tried to enforce its decree. The Norfolk road showed by comparison that its rates on truck were lower than those charged by lines on the main land, that these rates left the company at the end of the year without profit, and that they were really fixed by water competition and therefore must be reasonable. "Favored by nature and doubly favored by these lower railroad charges," says the court, "if the citizens of this peninsula are still unable to secure a profit upon the sale of their vegetables, the misfortune cannot in truth or reason be ascribed to the freight tariffs of the defendant company." The case is a good example of the position taken by certain classes of our citizens who clamor for lower railway charges regardless of consequences. Even a railway cannot overturn all the laws of trade, or continue long to carry stuff below cost or without a reasonable profit, even to please the Delaware farmers.

THE receivership of the Union Pacific may lead to great complications. The second mortgage bonds of the road guaranteed by the federal government fall due from 1895 to 1898. Figured to maturity and adding the interest in arrears, the total is not far from $60,000,000. The first mortage also falls due at the same time, aggregating $30,000,000 more, while the Collateral Trust notes, about $12,000,000 and covering all the bonds and stocks of branch and auxiliary roads in the treasury, mature in 1894. The total indebtedness of the system is about $250,000,000. The system is composed of two main lines from Omaha to Odgen, Utah, and from Kansas City to Denver, together with a large number of subsidiary roads which vary greatly in their earning capacity and intrinsic worth, but which furnish to the main lines a large part of their traffic. Without these auxiliary lines (controlled by the Collateral Notes and by the branch bonds in the hands of the public) the main lines could not earn interest on anything but the first mortgage, leaving the government lien all but worthless. On the other hand, the subsidiary roads have no outlet except over the main lines. If the government should compromise by exchanging its present mortgage for a long time loan at low interest, the company, when normal times returned, would arrange its finances and go on. Without such a compromise the situation presages conflict and loss. The proposition of Nebraska people that the government shall discharge the debt so that their rates may be reduced, is ingenious but hardly defensible. Nothing is certain as to the outcome until the federal policy is disclosed through Congressional action though a committee is now trying to arrange a plan of reorganization to be submitted to Congress and the private bondholders, which it is hoped will be acceptable to all interests.

So many important companies are now in the hands of receivers that questions concerning their power and duties are timely. One of these questions relates to contracts. When a receiver is appointed for a corporation, he must operate the property as an officer of the court and strictly in accordance with the policy which at the moment seems best for it. Hence it is quite common to find receivers cancelling contracts made by the old corporation which are no longer profitable. Such for example are the payments of guaranteed interest on branch-line bonds which now cover roads of little or no value to the company. If the fact of direct loss be clearly shown to the court, the judge will order the lease discontinued and the payment stopped. In such cases it is supposed by many that the action of the court is final and that the liability of the corporation is at an end. This supposition is incorrect. A court having possession of the property of a corporation must run it so as to yield the most revenue at the moment, nor can any bondholder or other claimant dispute such action. Yet the force of the original contract survives, awaiting its opportunity.

If a compromise is made with other creditors, so that the original company is able to take back its property, then each of these old and uncompromised contracts revives as to its original claim and also as to all accumulations and arrears of interest during the receivership. All are liens on the property. It is because of this fact that reorganizations are usually accompanied by the formation of a new corporation to which the property and franchises of the old company are conveyed at foreclosure. By foreclosure those other claims are extinguished. But without foreclosure proceedings they are still claims against the old corporation.

THE matter is complicated when for any reason it is desirable to retain the old charter. A wiping-out of old debts would then be no object compared with the loss sustained by the relinquishment of the old rights. In the case of the Texas and Pacific an arrangement was reached by which a new capitalization was effected based on the old; thus a valuable federal charter was retained. But where no compromise is possible, because many varied and conflicting interests are unable to reach any agreement, it sometimes happens that receivers remain in possession for a long time until the different creditors are wearied into accepting some plan of readjustment. The point now to be considered, however, is the fact, not generally understood, that a company whose rentals and guarantees are a source of danger to its solvency can throw off those burdens only by a sale of its property and franchises to another corporation. Any rehabilitation which preserves its charter or the existing stockholders' rights, must deal also with these rentals and guarantees. If valid otherwise, there will still be a claim upon the property after the receivership is discontinued.

CIVIL ENGINEERING.

Conducted by John C. Trautwine, Jr.

A GREAT object-lesson, in civil as well as in other engineering, and indeed in every conceivable object of study, has closed. The students have gone to their homes, and the professors are following their example. The schoolhouse, vast and beautiful and instructive beyond description, begins, alas, to present the air of a banquet-hall deserted, and must soon resolve itself into the chaos from which it sprang.

The cloud-capped towers, the gorgeous palaces,
The solemn temples,....................
......................shall dissolve ;
And, like this unsubstantial pageant faded,
Leave not a rack behind.

The World's greatest and grandest Fair is at an end, but the lessons it has taught will live on in the minds of men. Perhaps no other space of equal area within the exhibition was so full of matters of interest to the civil engineer (using the term now in its narrower sense) as was the southern end of the gallery of the Transportation building, devoted to the exhibition of the engineering interests of Germany. Professor Reuleaux—whose monumental work, "Der Konstrukteur," has just been laid before the English-reading public by Suplee's masterly translation—Professor Reuleaux, upon his return to Germany after the Centennial Exhibition of 1876, added a small but important stone to the already well-established structure of his immortality, and at the same time incurred the widespread disfavor of his compatriots, by characterizing the German exhibits at Philadelphia as "billig und schlecht" (cheap and nasty). The seed seemed to have fallen among thorns, but it has borne magnificent fruit in the character of the German exhibits, and notably of the German engineering exhibits, at Chicago, which were as far as possible removed from anything like cheapness.

One of the most prominent of the exhibits in the German gallery of the Transportation building consisted of the models representing the North sea and Baltic (Nord-Ostsee) ship-canal. This great work extends from Brunsbuettelhafen, on the right bank of the Elbe near its mouth, via Rendsburg, through the historic Schleswig-Holstein to the mouth of the Eider, near Kiel, on the Baltic, where the canal commission has its seat. It is sixty-one miles long. Its bottom and top widths are 72 and 213 feet respectively, and its mean depth 30 feet. It was begun in 1886, and it is expected that it will be completed by the end of 1894. The cost is estimated at $39,000,000, and, judging from present indications, it is believed that this figure will not be exceeded. Its prime object is of course to avoid the tedious and perilous voyage around the Danish peninsula and through the Skagerrack, but the German government of course is not blind to the advantage of access through German territory to the North sea. The writer had the good fortune to listen to a description of this model from the lips of Herr Theodor G. Hoech, technical attaché to the Imperial German legation, and was not a little interested at the recital of some of the considerations that were kept in view in designing the work. To American ears, for instance, it sounds curiously to hear that the engineers had proposed thus and so, but that "the emperor" wished it otherwise, and that the plans were "therefore" modified accordingly. We realize, too, something of the price the continental nations must be paying for what they dignify with the name of patriotism, when we are told that all bridges and locks had to be built in duplicate, to provide against possible crippling in time of war. There will be tidal locks (double, of course) at each end, but otherwise the canal will be free from locks. Six passing places, each 1476 feet long, 197 feet wide, and 7½ miles apart, have been provided in order to allow two large ships of war to pass, and numerous opportunities for passing are afforded also by the lakes along the course of the Eider, through which the line of the canal passes.

A fine model, 26 feet long and 10 feet wide, showed the arrangement of the locks at Holtenau, at the Baltic end of the canal, and the necessity for duplicate lock-chambers was utilized in the model by constructing the northern chamber of metal, so that it could be filled with water, and the southern of wood and in such a way that portions might be withdrawn so as to expose the internal construction. Even the hydraulic motors were faithfully reproduced in the model, but, owing to the smallness of the motors in the model, it was not convenient to operate them by water power and they were accordingly worked by hand, as indeed their larger prototypes could also be operated in case of their failure to work hydraulically as intended.

SCARCELY less interesting, although illustrating a piece of work geographically more remote, was the exhibit of G. Luther, engineer, of Brunswick, Germany, containing models and drawings illustrative of the gigantic task of regulating that "highly international" stream, the Danube, in its forty-eight miles of rapids, culminating, at the point where Hungary, Servia and Roumania meet, in the far-famed Iron Gate. This work is being carried on by means of coffer dams, which are pumped out by turbines operated by water-power derived from the river itself, and the rocky obstructions to the channel are thus attacked and removed in the dry. The completion of this work, together with that of the Danube-Oder ship-canal, will give a continuous water-way, "straight across Europe," from the Caspian sea to the Baltic and North seas.

VISITORS who had wandered southward through the colossal locomotive exhibits of the Transportation building and its annex, and who came out upon the unique display of the "Georgs-Marien-Bergwerks und Hütten-Verein" at the southern end of the annex, were apt to suppose at first sight that here a portion of the building had been left unoccupied, or at least that the exhibits intended for it had not yet been installed. No greater mistake could have been made; for this space, devoted to a most remarkable collection of specimens of railway track from all countries, and from all times during which railway track has existed, was remarkable as well for its completeness, its accessibility, and the extent of information furnished, as for its great extent. But although in length and breadth this was one of the most extensive exhibits in the Transportation building, in height it was, by reason of its nature, singularly inconspicuous, and hence must have arisen the impression referred to.

Beginning with a bit of an ancient wooden road of Roman construction, dug up in the neighborhood of Osnabrück, where this much-titled corporation has its establishment, this exhibit contains no less than sixty-eight full-sized specimens of track and track-fastenings, or what our British brethren call "permanent-way." The collection was arranged with very close adherence to chronological order. Immediately following the Roman road referred to, was a piece of wooden railway used in mines in the remote parts of Hungary from the sixteenth century to the present day, the rails composed of round logs, which were tapered off into "points" to form switches when required. Following this, again, was shown a bit of what was probably the first iron railway in existence, the Merthyr Tydfil tramway in South Wales, with its rails of cast-iron angle bars nailed to rough stone sleepers. The collection included Stephenson's Stockton-Darlington railway, of 1820, the first ever operated by steam locomotives; the U-rail used by the Great Western of England from 1850 until about two years ago, and at one time employed on the Camden and Amboy; the cast and wrought iron round and oval "pot sleepers" so commonly used in Egypt and in India; and a very full and instructive assortment of modern designs for track laid with iron and steel cross ties and longitudinal sleepers, not omitting, of course, those of the Georgs-Marien Verein itself.

If we are to accept Tredgold's definition of civil engineering as the art of directing the forces of nature for the use and convenience of man, we may perhaps define military engineering as the art of directing those forces for the abuse and inconvenience of the other man. And here, too, the Germans were well to the fore. Few were the visitors to the Fair who failed to see the great Krupp exhibit, with its wonderful display of engines of destruction. When the delegates to the engineering congress visited the Fair, they were granted an exclusive visit to this building, which was, for the time, barred to all others. Here the great guns were manipulated for the edification of the visitors, who had opportunity also to disabuse their minds of the impression, if it existed, that the Krupp establishment devoted its energies solely to the manufacture of artillery, armor plates, and projectiles; for some very remarkable examples of its work in manufacturing propeller shafts, steel castings, locomotive wheels, and frames, etc., were also shown.

At the north entrance of the United States government building was exhibited a specimen wicket from a movable dam of the Chanoine type, such as is now being built in the Great Kanawha river, West Virginia. This great work consists of the building of two fixed and eight movable dams, the latter all of the Chanoine pattern, in which the dam consists of a series of wooden wickets, each upheld by a separate iron prop and horse. Prop and horse are so jointed together as to form, when the dam is in place, an inverted V, which, when it is desired to lower the dam, is allowed to flatten out and lie in a straight line upon the sill of the dam; the wicket, of course, accompanying them and resting upon them in a horizontal position. The work, begun in 1875 and now nearing completion, it is under the charge of Colonel William P. Craighill, United States engineers, and Mr. Addison M. Scott, resident engineer.

A similar dam is in operation at Davis Island, in the Ohio river, and another is being constructed in the same river below the mouth of the Beaver. The object of such dams is, of course, to allow of slack-water navigation during times of low water, and, by lowering the dams out of the way, to afford unobstructed navigation, as if no dam existed, during high water.

The French are our leaders in this respect, movable dams having been in use in that country for many years, and they have developed a great number of widely differing types in addition to the Chanoine; but owing, no doubt, to the much greater width and depth of our American rivers, our engineers have greatly improved upon their French prototypes in many matters of detail.

One of the most important improvements in the Chanoine type of dam (and this one, like the general design, is of French extraction), is the Pasqueau heurter. The heurter is the iron block or catch in which the lower end of the prop rests, when the dam is up. Prior to the introduction of Pasqueau's improvement, the feet of the props were dislodged from their seats in the heurters, by means of a long bar, armed with a series of lugs, one lug for each prop, and called a tripping bar. This bar extended along the length of the dam, close to the feet of the props, and was worked by gearing placed at the end of the dam. When this gearing was operated, the tripping bar moved longitudinally, and one of its lugs after another came in contact with its appropriate prop, throwing the foot of the latter out of its seat in the heurter and allowing it, with its horse and wicket, to fall. But the operation of such a bar, liable, as it was, to become tangled with weeds and stones, was exceedingly troublesome, even upon the narrow and shallow rivers of France; and upon our wider and deeper streams its use would have been practically prohibitory to the use of the Chanoine wicket. The Pasqueau heurter is so designed that no tripping bar is necessary. An up-stream pull on the wicket by means of a chain draws the prop out of its seat in the heurter, and, upon relaxing the chain, the foot is guided away from its seat and, on to a long flat inclined plane, upon which it slides, allowing the prop to fall.

AN interesting illustration of the refinement of methods and of the rapid substitution of machine for manual labor which characterize modern civil engineering, was the noisy but undoubtedly effective dump-car of the Thacher Car and Construction Company, the abrupt snorts and shocks of which were apt to startle the unsuspecting passer-by. In this car the tipping of the body, and the resulting dumping of the material carried, are effected by a compressed-air cylinder provided upon each car and worked from the engine. A second and smaller cylinder, also worked from the engine, releases the latch by which the body is held in its normal position, and thus permits the dumping of the load. All the cars in a train may thus be dumped simultaneously, and, if desired, while the train is in motion, with an obvious gain of time as well as a great saving in labor. The car exhibited was a four-wheeled car holding 9 cubic yards, or say 40,000 pounds, but the company is prepared to furnish eight-wheeled cars holding from 60,000 to 80,000 pounds.

THE Ferris wheel, that landmark of the Midway Plaisance, came in for a special share of Professor Reuleaux's commendation. That eminent authority expressed himself as regarding the wheel as one of the finest examples he had seen of the skillful and economical adaptation of material to its destined purposes. It is gratifying to know that this movable Eiffel tower, as it might be called, has proved a very handsome financial success. Its designer, Mr. George W. Ferris, is, we understand, the engineer of the projected bridge to span the Ohio river between Cincinnati and Covington.

Those who are familiar with the Fair will not be surprised to learn that that other innovation in the matter of passenger transportation, the "moving" sidewalk, is *standing*, pending negotiations for its removal to another site. This remarkable and novel structure, which moved, not vertically, like the Ferris wheel, but horizontally, consisted, as every one knows, of two endless platforms, moving, one at moderate walking speed and the other at double that rate; the latter provided with seats, and the former with upright posts to assist passengers in entering and alighting. The combinations of movements necessary to an easy and dignified performance of these operations formed quite an interesting study to the uninitiated, and the writer can still see in his mind's eye the editor of one of our foremost engineering weeklies wrestling with the practical side of this problem. Unfortunately, this enterprise differed from the great wheel not only in the position of the plane of its movement, but also in the matter of financial returns. The company operating it claim that this was chiefly owing to delay on the part of the Exhibition authorities in furnishing power, so that instead of beginning to run at the opening of the Fair on the 15th of April, it did not go into satisfactory operation until about the 1st of July; and visitors to the Fair will remember that the sign, "The sidewalk is not running," was an almost daily spectacle. While it did run, however, it was unmistakably popular, affording, as it did, a delightful rest from the fatigues of Fair-seeing, together with a whiff of the cool breezes from the lake. It was run with 125 horse-power, and Mr. Schmidt, the secretary and consulting engineer, claims that at one time it carried six thousand passengers.

In comparing its financial results with those of the Ferris wheel, it is important to bear in mind that while the latter charged 50 cents per trip, the sidewalk charged but five cents; and that whereas a trip on the wheel meant two turns, neither more *nor less* (however sea-sick the rider might be at the end of the first), on the sidewalk "you could ride as long as you pleased."

Mr. Schmidt informs us that a movement is now on foot to construct a series of loops on this system in the business portion of Chicago. These loops will be elevated, supported upon lines of single columns, and the whole structure will be light and ornamental. This may well be, for the weight of the rolling stock is inconsiderable when compared with that of the ordinary elevated railway with its locomotives. None of the loops will be over 1½ miles long.

A REFERENCE to the engineering features of the Fair, however incomplete, should not fail to include the Engineering headquarters, established by the associated engineering societies of the country and maintained at No. 10 Van Buren street, close to the business center and to the best means of reaching the Fair-grounds. These rooms, most acceptably presided over by Mr. Schmidt, and open to all visitors, domestic or foreign, who came accredited from any of the associated societies, were well supplied with the technical journals and other necessaries of engineering life, and formed a most convenient rendezvous for visiting engineers of all "persuasions."

PROFESSOR FRANZ KREUTER, of Munich, whose visit to this country last summer afforded so much pleasure to those who were fortunate enough to meet him, and whose wonderful command of English was a standing source of wonder to them, has submitted to the Institution of Civil Engineers a paper on "The Design of Masonry Dams," in which he proposes a new method of treatment of the cross-section. He divides the section, horizontally, into four portions, and gives, for each of these, formulæ for its dimensions and directions for determining its configuration.

At the same meeting were presented three papers, treating of gravity water-supplies in India, one at Tansa, with a masonry dam 135 feet high, or 7.5 feet higher than the great Vyrnwy dam erected for the water-supply of Liverpool, one at Baroda with an earth embankment 54 feet high, and one at Jeypore with an embankment of sand, without a core-wall, 61 feet high.

In the musically named Tuolumne river, in California, is being erected, for irrigation purposes, the La Grange dam, 129 feet high, 117′ 9″ wide at base and 360 feet long. It was begun in 1891 and will cost $600,000. Its ground plan is a curve, which, by one of the accounts, is of only 320 feet radius! The large stones used in its construction were cleared of débris by a water jet under a head of 75 feet.

FROM being one of the most backward of American cities in the matter of railway terminals, Philadelphia has, within the last decade, and notably within a year or two, come forward into the very front rank. The station of the Philadelphia and Reading railroad, at Twelfth and Market streets, recently completed, and that of the Pennsylvania railroad at Broad and Market streets, which was constructed some twelve years ago, but which is now being very greatly enlarged, are certainly far and away the finest railway stations in this country; and while, in respect of size and number of stations, Philadelphia is certainly exceeded by both London and Paris, it may well be doubted whether two finer stations than these exist anywhere. Both train-sheds are spanned by three-pinned arched roofs. The span of the Reading shed is 259 feet, while that of the Pennsylvania is 300 feet 8 inches. The latter is claimed to be the greatest single train-shed span in the world, although it is exceeded by the great spans of the Machinery Hall at the Paris Exhibition (362 feet 9 inches) and by that of the Manufactures and Liberal Arts Building at Chicago (368 feet). The Pennsylvania train-shed is 589 feet long (about 64 feet shorter than that at Jersey City) and contains sixteen tracks, with their platforms. The extension of the head-house, like the original structure, is of dark red brick. The newer portion is of conspicuously plainer character than the older, and many are the criticisms upon the resulting want of harmony. The Reading head-house, on the contrary, forms a very harmonious and imposing whole, although, to the mind of the writer, the light-colored brick, with its light-colored and highly ornamented trimmings, produces a less pleasing effect than the more sombre material of its great rival. Both terminals are fitted with new electro-pneumatic interlocking switch and signal systems, installed by the Union Switch and Signal Company.

WHILE the canal, as a means of transportation for small boats, seems to have been fairly pushed to the wall by its smart competitor, the railroad, it will be seen that the case is far otherwise with the ship-canal. The two great interoceanic canal projects for the American isthmus are indeed not in a promising way toward early completion, but the Nord-Ostsee canal, to which we have referred, will no doubt be speedily pushed to completion, seeing that the "military necessities" of a great European power are behind it; and the past year has witnessed the completion of two great undertakings of this kind, little if any less remarkable, the Corinth and the Manchester ship canals. The former, like the great German canal, cuts through a peninsula, and is designed to avoid its tedious circumnavigation.

The Corinth canal, passing through territory of even far more ancient historical interest than that of Schleswig-Holstein, follows the line of a similar enterprise begun, but abandoned, by the Emperor Nero. It crosses the isthmus at its narrowest point and in a straight line. Its most remarkable engineering feature is its great rock cutting about 1.2 miles long and over 250 feet deep at its deepest point. Like the Nord-Ostsee canal, the Corinth canal will have locks at its ends only.

The Manchester canal is intended to circumnavigate, not a peninsula, but the dock charges at Liverpool and the railway tariffs from that port to Manchester, which town, by the construction of this work, has now made a sea-port of itself. It is one of the sad curiosities of our system of social economy that the furthering of the interests of one man or firm or corporation or community, too often involves the ruin of those of another, and this was notably the case between Liverpool and Manchester, the town authorities of Liverpool and the railway people fighting tooth and nail to prevent the consummation devoutly wished by the Manchestrians.

This canal, which cost fifty million dollars and was six years in building, is 35½ miles long. Extending, as it does, from an arm of the sea to an inland town, it is radically different in profile from the other two canals mentioned, which are at sea level at both ends. It leaves the estuary of the Mersey by means of locks at Eastham, on the left bank, six miles above Liverpool, and its tidal portion extends from this point 21 miles to Latchford. Here and at several points above, are locks. The total rise, from ordinary level in the Mersey at Eastham, to the terminus of the canal at Manchester, is 60 feet. At Barton, the ship canal is crossed by the previously existing Bridgewater canal, the latter being carried over the ship canal by means of a swing-bridge. The swing consists of a caisson, which, when swung open, is closed at its ends, as are also the ends of the canal communicating with it, so that each retains the water within it. The ship canal, above Latchford, constitutes the outflow of the Irwell and other small streams which are frightfully polluted by Manchester and other large towns; and vigorous measures are being taken, looking to their purification.

SOME remarkable work has been done on the New York Central and New York, New Haven and Hartford railroads in connection with the straightening of the line and the widening of the road-bed. On the New York Central, the Mott Haven station, a brick building 185 x 35 feet, with a tower 80 feet high and 19 feet square, was moved horizontally by screw-jacks, worked by hand, a distance of 50 feet, while on the New York, New Haven and Hartford, near Milford, Conn., 64 miles out from New York, the rails of a double-track section nearly two miles long, still spiked to their ties, were moved bodily, one track at a time, a distance of from 20 to 30 feet horizontally and raised from 6 to 9 feet vertically, being slid upon skids into their new postions. The work occupied a force of 261 men ten hours, including fifteen minutes for luncheon.

MINING & METALLURGY

Conducted by Albert Williams, Jr.

UNTIL the statistics and estimates for the past year are available it is rather premature to draw conclusions, at least in detail, but it is safe to say that on the whole 1893 has not been a satisfactory year for American mining and its related industries. Many of the leading products will show a decline in the total output; nearly all have been marketed at much lower prices than in the preceding year; and with most of those items for which a gain in production will be reported, this will be more than offset by low figures for sales. All branches have been injuriously affected by the general financial depression; though in the case of gold-mining there have been counteracting influences which have stimulated its prosecution and in many places increasing the yield beyond the normal for recent years. Wages have been lowered and very many men thrown out of employment; yet, considering the severe tension, labor-troubles have been less frequent and intense than might have been looked for. The old year goes out and the new one comes in with a slightly improved feeling in mining circles as a whole; and with the promised revival in business at large mining will soon regain lost ground, except in those lines in which adverse influences not connected with the general prosperity at are work.

THIS Department is in receipt of a very fair and straightforward statement from the director of the "Correspondence School of Mines," at Scranton, Pa., in regard to comments made in the November issue of the Magazine upon an advertisement put forth by that institution, which was thought to be somewhat misleading, or at least liable to misinterpretation, inasmuch as, without qualification, it seemingly claimed that mining and prospecting could be "taught by mail." The instructor in charge of this branch of the course, who is of course not responsible for the wording of the advertisement, also sends an explanation. Besides these, a number of letters on the subject have been received from practicing engineers, instructors in technical schools, and intending students, for the question of the different and best means of acquiring an engineering or technical education is one that is always of wide interest.

Not to go over the ground anew, it may be stated briefly that the stand taken in this Department is simply this: Any education, however limited, for whatever application and however obtained, is better than none. The principle that "a little knowledge is a dangerous thing" is not true, though it furnishes a taking epigram. As to mining-schools, they all do good; more or less according to conditions. Where they are most likely to do harm is in claiming too much, and thereby giving students and graduates a false notion of things, best expressed by the slang term "a big head," which swelling is reduced by experience and time. In regard to the correspondence system no fault has been found here; on the contrary, it was much commended, within the evident limitations, and an examination of full sets of prospectuses bears out this view. But the wording of the advertisement was, as already pointed out, extremely objectionable. With that amended, there is nothing more to be said that does not apply in greater or less degree to all systems of technical education. In justice to the Scranton school, the most pertinent portions of the statement of its head, Mr. T. J. Foster, are here quoted:

Our advertisements are written in a general way, to make them as short as possible. In writing them we take it for granted that every one knows that we cannot teach mining practice in a school,—only theory, and that practice and experience are necessary to successfully pursue any business. Through reading one of these advertisements you have fallen into the mistake of thinking that we propose to make miners of persons who are not actually engaged in mining. The regular mining schools may profess to make mining engineers or mine officials of the young men who study with them and take advantage of the summer classes held under their auspices, but I do not believe it can be done. I have never known of one of these young men after graduating who was qualified for anything but a subordinate position on a mine surveying corps or on the staff of a mine. I have known many of them, however, who, having supplemented their collegiate educations with years of mining work, have grown to be thoroughly competent mining engineers and mine superintendents, and I believe that a course in a regular mining school followed by three or four years of work in a mine is the best way to make a good mine officer. If, therefore, the regular schools cannot turn out mining engineers and mine officials without practice, we cannot expect to do so in correspondence schools, because it is not claimed for the correspondence method that it is as efficient as oral teaching or that it equals in results the regular methods of teaching. Knowing this, we make it a rule not to enroll as students people without experience. If any such write to us (there are very few who do so) for our circular of information, they find out on reading it that the school is only intended for men actually engaged in mining or those who are so situated that they are familiar with mining terms and mining. If such people write to us with a view of enrolling in the school, we discourage them from doing so. . . .

That we can educate practical miners and mine officers in the theory of mining and the sciences related thereto by correspondence, there is no question. Any student who will apply himself can learn by the correspondence method. It will take him longer than if he is in a regular school, but if he has the ambition and the habits of application he will get through. We have working miners over forty years of age among our pupils who two years ago could not add five and five together, who now thoroughly understand and can readily work out all the formulæ connected with mine ventilation. . . .

Our school is only intended for people actually engaged in the mining industry, its object being to furnish an education in the theory of mining and the sciences related thereto to men engaged in mining who are not able to obtain that education in any other way. . . .

T. J. Foster.

A very successful instructor, the professor of geology and mining engineering in one of our best institutions, who takes very high ground as to the qualifications of mining engineers, and who strenuously opposes the granting or use of the title "E. M." except to and by graduates of chartered institutions, writes:

. . . I am thinking seriously of abolishing the course for an "E. M." degree, as no course will give in four or five years all that an "E. M." should carry. We are specializing so much that I feel that we can go as far as a "B. S." and give a student the rudiments of mining or of metallurgy in four years—and no more.

I want to say that I differ from you in regard to "summer schools of mining." I do not propose to graduate *miners*, but *engineers*. We are so near the mines that the students go on trips every week or two, during three and a half years, and see all that there is to be seen. On vacations I get them places where they can get work in draughting and constructive work, but never in the mines as *miners*. I have them study outside matters, etc., but I have seen enough of students at summer schools to see that they learn nothing of any importance by a stay of thirty hours in any one place.

The Ways and Means committee of the House, and indeed all members of both House and Senate, have a lively time in prospect in the discussion of the new tariff bill in its application to imports of ores, minerals and unmanufactured metals. Two points which are destined to be grounds for especially sharp contests are the provisions regarding importations of bituminous coal and of silver-lead ores. As to the latter, the situation is somewhat peculiar and the sentiment of Western miners is divided. The great majority of the producers energetically protest against a low duty or placing them on the free list; they would prefer to shut out the Mexican and other silver-bearing ores by a prohibitive tariff. On the other hand, those smelters in the Southwest which draw largely upon the Mexican ores, and a certain number of miners producing "dry" ores, would be benefited by the encouraging of importation of smelting ores, but they are in the minority. Like all other tariff questions it is a matter of local self-interest and not of broad principle, and it is common to find lead ore producers who are free traders as to all else drawing the line where direct competition comes in. Meanwhile the low prices for lead, mainly due to apprehension of a reduction in duties on ore and metal, have compelled many large but low-grade lead and silver-lead mines to suspend operations, for with both lead and silver at such low figures their position has become critical.

THE relation of the World's Fair to the mining industry, discussed elsewhere in this issue of THE ENGINEERING MAGAZINE by Dr. R. W. Raymond, can be considered dispassionately now that the great show is over. All through the earlier stages of preparation and exhibition there were constant complaints from each of the States and Territories, and from each of the branches of mining, that they were not adequately represented, and on all sides the men responsible for the collection, handling, and presentation of the exhibits came in for adverse criticism. Yet as a whole the mineral display of this country was so much in advance of anything before attempted, and the interest taken by several foreign countries in bringing hither their fine displays was so marked, that visitors who previously had given little thought to such matters had their eyes opened. As a whole, the popular rather than the scientific interest predominated —as was perhaps fair, considering that among the viewers there were probably a hundred curiosity-seekers to one student.

ON the breaking up of every similar exposition there has always been, as was inevitable also in the present instance, a regretable loss of valuable material, brought together at so much expense and with so much effort. The loss is partly in the actual disappearance of specimens and partly in the dismemberment of collections which derive most of their value from their exhibition as units and for comparison. Some of the exhibits intrinsically most valuable find their way back to their original owners; but the great mass are not so returned. Machinery and available appliances are not lost, but the ores, minerals, etc., in part disappear unaccountably. In the present instance the efforts to maintain a permanent Columbian exhibition, for the California mid-winter fair, for State and educational institutions, etc., have doubtless had a beneficial influence.

THE great utility of accurate mine maps, wherever there are workings of any considerable extent, actual or projected, is universally admitted. So also is their absolute necessity fully recognized for mines, in which slight errors may involve danger to life and property. In all large mines it is of the highest importance to keep the surveys and plats well up to date, without regard to the element of safety, if operations are to be directed intelligently and to the best advantage. Mining men understand this thoroughly, though it is true that they do not always act up to their convictions, and it is hardly fair to assume that they are in general unwittingly careless or deliberately neglectful of the importance of the matter. This assumption has been made, in a manner involving a very serious accusation, by the editor of a valued technical exchange in discussing the recent Mansfield mine disaster (noticed in the December issue of this Magazine). Regarding this, a very competent authority, Mr. Richard A. Parker, of Marquette, Mich., sends us the following communication:

. . . The editor, sitting in his chair, with Argus eye sees his lecture on mine maps (excellent in its way and worthy of attention) and the mine disaster, and calmly and judicially proceeds to connect cause and effect; that is, no maps, hence the accident. I have been in the mine a number of times, and, without fear of contradiction, am confident that the accident was in no way connected with an absence of maps. The men were working at least 400 feet below the river-bed. At each line, 60 to 80 feet apart, fairly heavy backs of ore were left, to support the mine, and even if "the miners had been digging away blindly and without direction in the bowels of the earth," so long as they did not run drifts up-grade so as to come out at the surface under the river their blind digging may have been and probably was a "loss to the operating company," but in no way did it, or *could* it, jeopardize their lives.

The cause of the filling of the mine has been argued in court, and it is stated as the Mine Inspector's belief that the trouble arose through the giving way of a timber shaft, located very close, I think within ten or twelve feet of the river ; this may be so, as I have not seen the mine for a year.

The ore deposit stands nearly vertical in a bed of Huronian black slates, which have a course approximately north and south ; the Menominee river is the east boundary of the property, and at this place has a course parallel to the strike of the slates ; the dip is to the west, and about 75 to 80 degrees from the horizon. I incline to the belief that the extraction of ore weakened the hanging-wall slates, allowing them to sag, say, at the middle of the workings ; this sag caused the slates to partly open at the surface, and when this was accomplished, it took but little time for a river of the size of the Menominee to wash out soft ore, and follow the cleavage of the slates down and into the mine. When I first examined the mine, I particularly laid weight on the method to be followed in mining the ore, for two reasons : (1) as the ore-seam was narrow (averaging 22 feet), by timber methods, a large proportion of the ore had to remain behind, and (2) for safety I advocated blasting the greenstone bluff tramming the rock by gravity to the mine and filling it.

SOME queer notions about mining get into print. A correspondent calls attention to an extreme instance of how the simplest statements become misunderstood and distorted in the course of handling by successive newspapers. In this case a Texas daily paper has got hold of a description of the steam-shovel method of iron-ore mining, from some authentic source, and after appropriating the original account, which is perfectly correct, is moved to add a few words of editorial comment. The Texas editor is much impressed by the wonderful economy of the steam-shovel system, especially from the statement that in one mine on the Mesaba range the cost of mining (apart from stripping and all other expenses) had been brought down to four cents a ton. He does not stop to learn or consider what are the conditions under which it is possible to use the steam-shovel, but jumps at once to a general conclusion and gravely observes that "as this machine handles as much ore in four minutes as one man can in a day"—which is quite true in the particular and peculiar case cited—"its adoption in the mines all through America may be looked for!" There is nothing so very amusing or exasperating in finding this sort of thing in a daily newspaper : the strange part of the story is that the whole article is reprinted without comment or explanation in one of the best of the technical journals, and that it has since been innocently borrowed by other papers and is now floating through the reprint columns of the press of the country, where it may possibly do harm by inducing false ideas of what is practicable in the economies of mining. As our correspondent points out, only mines of iron ore which can be laid bare cheaply by stripping the surface covering, which are soft enough to be attacked by a shovel (thus practically confining the system to certain red and brown hematites in limited areas), and which are thick enough vertically to pay for the removal of the surface material, are to be considered as within steam-shovel limits. With such statements in a technical paper as that above quoted, we may expect to see prospectuses of new iron-ore companies advertising the use of the steam-shovel *underground*, and quoting mining costs at four or five cents a ton, since down in the mine there would be no stripping charge—a most blissful state of things (for the promoter).

This is only one illustration of a very common tendency to seize upon phenomenal records, made under peculiarly favorable circumstances and usually by working on the very large scale, of mines or metallurgical establishments, and, by taking such records as of standard practice, apply them as a basis for estimates in other cases, where the conditions are wholly unlike or even prohibitive.

DURING the first six months of 1893 the total quantity of pig-iron produced in

Great Britain was 3,665,537 long tons,—an increase of 874,619 tons over the output for the corresponding period in 1892. This increase was partly due, however, to the lower standard of comparison caused by the falling-off resulting from strikes in 1892, and since the close of the half-year and up to a short time ago the rate of British pig-iron production showed a diminution. Toward the close of the year a revival of activity set in, and at the present time the industry is in an improved position again. The make of Bessemer-steel ingots in Great Britain during the first half of 1893 also showed a considerable increase (134,896 long tons) over the output for the six months of 1892.

THE English correspondent of the *American Manufacturer* (Pittsburgh), commenting on the statistics of the British Iron Trade Association, from which we obtain the foregoing figures, deduces an interesting comparison as to the relative positions of England and America in regard to the iron-ore supplies necessary in both countries for iron and steel production, from which it appears that while of the total consumption of iron ores in the United Kingdom the foreign ores are more largely depended upon (25 per cent. against 12 per cent. ten years ago, or about double), in this country the furnaces are increasingly drawing upon domestic ore supplies and becoming correspondingly more independent of imports. The iron-ore production of the United Kingdom has steadily declined during the past four years, while that of the United States has gained as steadily. In 1890 the two countries were on a level as to home iron-ore production, but in 1892 our iron-ore output had gained about 50 per cent., and was then about 5,000,000 tons ahead of the domestic ore production of the United Kingdom. Of course it must be remembered that in this country imports of foreign ores will always to a certain extent depend upon tariff legislation.

IRON-ORE mining in the United States has suffered in common with other cognate industries during the "hard times" and the general depression in business which set in last summer and from which the country has not yet recovered. Not so much has been heard or read of the losses, enforced idleness, privations and hardships of the iron miners as in the case of the silver miners, yet the last few months have borne with great severity upon thousands of the former, and especially in the iron mining districts of Michigan and Wisconsin, where so many men have been thrown out of employment and had to face the rigors of winter in an almost destitute condition, so that supplies of food and clothing from charitable sources outside were necessary. These men, a large proportion of whom are foreigners, who have been working at low wages and with little chance to lay by savings from their wages, and who are generally lacking in the adaptability or opportunity to turn their hands to other work and unable even to leave the iron regions, are more to be pitied than the silver miners. These latter have suffered much from the suspension of so many mines, but they have been able to meet the situation on better terms; many have found employment in gold mining, others have left the idle silver camps, and while there are still many of this class unemployed there are less of them out of work than was at first anticipated.

IT is a serious question whether in the United States the natural resources of the country have not in some directions been developed too rapidly. There are political economists who assert that there can be no such thing as over-production, in the sense that there can never be too much of the good things of the earth; but the dictum of the theorists, while very pretty as an abstract generalization, is small consolation to the producers, whether miners or others, when they find that the market will not absorb any more of their products on terms profitable to them, or at all. This very case of the iron-ore industry of the Lake Superior region is in point. Making all allowance for the disasters attributable to bad financiering and to unexpected setbacks due to the stringency of the money market, it certainly does look as if investment and development, tempted by the enormous mineral resources and possibilities of the upper iron districts, had been going ahead entirely too fast. Profits per ton of ore having been cut down by sharp competition to narrow margins, producers have been driven to the heaviest possible outputs individually in order to keep up the total net incomes, a course which has naturally resulted just as the similar policy (for which there seems to be no successful alternative in restricted production by agreement) has in the case of copper and coal mining.

FOR examples of heavy output in iron smelting, the records of the blast furnaces of the Edgar Thomson steel-works, the largest plant of the kind in Pennsylvania, are usually referred to. As Mr. John Birkinbine, in the last of his series of articles "From Mine to Furnace," in *Cassier's Magazine*, justly says, probably no better illustration of the development of the blast furnace can be offered than is given by the records of these works, concerning which he presents the following memoranda: The plant consists of nine blast furnaces, which can produce together over 2000 tons of pig-iron daily, and which have averaged a total output of between 1500 and 1600 tons per day. One of these furnaces, which completed 37 months of its present blast in April, 1893, had made in that time 370,000 tons of metal, and was running at the rate of 11,000 tons per month. The furnaces are 80 feet high with boshes 20 feet, 22 feet and 23 feet in diameter, and 90 feet high with boshes 22 feet in diameter. Thirty large blowing-engines supply blast for this group of furnaces. One hundred and twenty boilers furnish steam to drive the blowing-engines, the pumps and hoisting appliances, and 24 pumps are in constant use furnishing water. Thirty-three hot blast stoves heat the air supplied. One of these furnaces has reached the remarkable output, for a single day, of 623 gross tons of iron; in a week one furnace stack has made 3023 gross tons, and in one month one stack produced 12,800 gross tons; that is, in one month, one of these furnaces produced fully as much iron as twenty-five years ago would have been turned out in one year from the best and largest of the American blast-furnaces.

AN interesting bit of metallurgical history is contributed by a writer in *Industries and Iron*. It relates to Sir Henry Bessemer's famous "sun furnace," which, as the writer says, was "possibly well-nigh revolutionizing the world, let alone the science of metallurgy." The description is not quite clear, but it certainly is readable: "It was to attain a temperature of nearly 60,000°, and therefore fuse anything and everything; and I was assured that it would have achieved its object but for the stupid fault of an Essex lens-maker. The 'sun furnace' consists of a wooden building 35 feet high and some 12 feet square. A few feet from the ground a large inclinable mirror for catching the rays of the sun is fixed; the rays are reflected from this mirror on to a number of powerful superimposed lenses above, which, by a simple arrangement, were to throw the enormously concentrated rays upon whatever object might be in the crucible below. Such was the mighty plan, but the manufacturer of the upper glasses, instead of turning them out uniform, made them all different, and thus the focus was spoiled. The work and anxiety in connection with this sun furnace was so great that its deviser did not care to go over the ground again, and there the peculiar furnace remains—a remarkable monument of what might have been."

THE steadiness of the tin production in Cornwall is shown by the following figures: In 1892 the output was 9251½ long tons, as compared with 9353½ long tons in 1891. The value for 1892, however, was slightly higher than in 1891.

For the year ending April 30, 1892, Banca and Billiton (Dutch East Indies) produced 5755 and 6384 long tons respectively, or 12,139 tons together. These islands have been slowly increasing their output from year to year, but the rate of increase is fairly uniform as well as small.

Meanwhile, where is our American tin?

MACHINE SHOP PRACTICE

Conducted by Albert D. Pentz.

THE effects of cyanide potassium on iron and steel are interesting to a high degree. Machinists use two forms of this chemical—the ferro-cyanide, or yellow prussiate, and the fused white cyanide, with the iron removed. The effects of these two forms seem identical as far as the hardening of iron is concerned, and if they differ at all in effect, it is in the superior degree of strength possessed by the white cyanide. That a film of this substance melted upon the surface of a red-hot iron article can cause it to harden on the surface, which otherwise would remain soft after quenching, is a marvelous and a valuable fact. The question of how this is accomplished cannot be absolutely answered, but it can be conjectured to a probability. Cyanide potassium has a close affinity for sulphur—so great, indeed, that it will absorb that element from tarnished silver, for which metal sulphur, in turn, has so great a liking that its most attenuated vapors collect on spoons and other articles of plate from the atmosphere, forming a sulphuret in the form of a black coating on the surface. A great many of the smaller sizes of iron screw rods are coated with copper and some of them, at least, are merely treated in a solution of the sulphate of copper to produce this result. In this treatment the sulphuric acid leaves the copper in the metallic condition on the rod and attacks the surface of the iron. Hence there always is a sulphate present under the copper coating thus produced on screw rods.* In case-hardening articles made from coppered screw rods of the kind named it is found that animal charcoal has not a sufficient effect on so much of the original surface as has had no cut taken to remove the influence of sulphur from it, but where there has been a considerable amount of that surface removed to a reasonable depth and has thus exposed the iron beneath the influence of the sulphur, this charcoal prepares it to harden in a satisfactory manner. Now it is found by experiment, where the surface of such a screw rod does not become hard after treatment with animal charcoal in the usual case-hardening process, that cyanide potassium will neutralize the sulphur and assist this kind of surface to become hard. This substance does not work very well when mixed with the animal charcoal in the hardening case, because it does not spread freely but clings to the charcoal in a manner not clearly understood, and so closely that the metal under treatment receives but little, if any, of it. If the pieces be touched where needed by a piece of the cyanide as they are taken from the box to be quenched, it will serve. This is often not practicable, however, as in the case of a great quantity of small pieces which would cool too quickly for such treatment. In this case it is suggested that a quantity of cyanide be dissolved in water making a strong solution and articles be quenched in it.

HEATING steel articles such as small tools in a crucible filled with cyanide potassium is certainly bad practice. There is no certainty that all will be equally hard, for this substance has very treacherous habits with tool steel. Again, if articles be kept very hot a considerable time in a bath of this character the surface will melt and a thin layer of it will flow off. The writer had this experience with a number of small taps and found a button of steel in the bottom of the crucible after the taps were proved to have diminished in size. Cyanide of potassium is a very valuable sub-

*See answer to "B. V. M." in Machine-Shop Notes, in THE ENGINEERING MAGAZINE, June, 1892.

stance, but it is the most poisonous thing a machinist is likely to meet in his work.

WHILE the designing of drill jigs is among the elementary things in shop engineering, there is in the construction of them much experience that will serve in milling fixtures and in designing the higher branches of machinery to do automatically and sequently complete operations. There often is need of something that approaches genius to arrange a piece in a jig so that all the holes required in it may be drilled with one setting and that the piece may be secured by a novice with the certainty that it will not be sprung out of shape in the least. In these two particulars there is no difference between a simple jig and an elaborate perfecting machine.

WE are free to say that our experience shows us that the flesh side of leather is the best to place against the pulley when such leather is used as a belt. We know this to be contrary to the most usual practice, but this general practice is due to the ideas of belt makers rather than to those of belt-users. Traction is greater where the surface is elastic and has a clinging tendency than where it is hard and smooth. This is because this kind of surface clutches the pulley more securely by being pressed into all the pores and interstices of the metal or varnish. If a smooth hard belt were desirable, then of course a thin metal band would be the best thing. This needs no argument to prove its absurdity.

THE shafting in many shops has many things to condemn it. As a rule it has too much length between the hangers. Now no shaft of a size likely to be hung in a machine-shop should have its hangers farther apart than eight feet. In fact that distance is about right ordinarily. A small shaft, $1\frac{11}{16}$ inches in diameter, will be well enough supported that far apart for usual conditions. It will neither sag nor be sprung by correct belting out of alignment, and a shaft quite large, $2\frac{15}{16}$ inches, will have a sufficient number of supports at eight feet intervals to carry its great weight, that of its furniture and the belt strains. It is farther found that couplings are quite often placed at too great a distance from the supporting hanger. They should abut the hanger closely and never should be farther away in any ordinary case than twelve inches. Shafting is regularly made in sixteen-feet lengths, hence if the hangers are eight feet apart, all the coupling will be of the same distance from them. Then if the extreme end of a line of shafting be set out from the first hanger about one foot, the middle of each remaining coupling on that line will be one foot from each second hanger.

WHEN flanged couplings are forced tightly on the shaft, and keyed carefully, so that the keys bind radially outward and inward and do not fit on their sides, they are good couplings. These conditions, unfortunately, do not prevail to the same extent that flanged couplings do, and they sometimes give trouble of a very grievous kind. At first where such couplings are badly fitted, shafting will not run true. Afterward the line will spread because the shaft will slip out of the couplings endwise, and again, the shaft will grind out the coupling, wear out the key and its seat, and ruin in a few days what it costs much money and trouble to mend. Compression couplings of a kind that wraps the shaft are the best and cheapest. Other couplings that compress by short clamps do not seem to be satisfactory under heavy duty. There are, however, a great many good couplings. We have been looking for many years for some one to invent a coupling to fit the inside of the hanger box so that the spaces on a line of shafting that at present are occupied by couplings shall be saved, but the proper thing has not yet been found.

UNFORTUNATELY, the making of machinery is not compatible with cleanness, as the term is understood in a parlor or an office. Consequently a machinist gets his working clothes and his hands very dirty. Overalls and such garments can be made to protect the clothing to a great degree, but for the hands and arms there is no practicable protection. The only thing that can be done is to clean the dirty hands and arms after work, and that is no easy matter, for soap and water does not remove all or even a great part of the grime. We do not pretend that the method indicated below is the best one for removing the shop dirt from a workman's hands, but it is the best we know of and we are certain that it is efficacious and safe, which latter some of the chemicals sold for this purpose are not. After stopping work, do not wipe the hands with any hard cloth to help remove the dirt, for that merely rubs it into the pores, and makes it all the harder to reach and get out, in fact, do not rub the hands with anything at all. Do not use sal soda or any other alkaline compound except soap. Do not use coarse sawdust or sand, as both of them act the same as a coarse cloth. The first thing to be done is to take water and strong soap and make a heavy lather. With this, wash off, with much rubbing with the palm, all that can be got at by this process. Then, having procured some fine ground pumice stone, which still is not so very fine but that it has a palpable grit in it, make another lather from good mild soap and clean new water, for it is worth some trouble to get clean and have smooth, soft hands. When this lather has been well rubbed into the skin, take of the pumice about one teaspoonful at a time, and scour well each place where any dirt remains. The palms for instance, the thumbs, and the fore fingers, where the pores are deep, and the knuckles, all must be scoured well. Use plenty of water and but little soap, and after awhile no soap. Finally rinse well with clean water. Do not use gritty soaps, as they are not good and cost too much. Do not use warm water.

This rather troublesome treatment will take off all the dirt and make the skin soft and smooth. Buy the pumice at a painter's-supply store, as it will cost less there than elsewhere.

LET us look at this matter of the contract system of manufacture. Are the workmen benefited by this system? Or is the owner benefited? Working for a contractor, a man has to serve two masters—the contractor and the employer. He must earn a profit for his employer as large as he would if he worked directly for the concern, and one for the contractor also. When the price to the contractor is reduced for work under his contract, no one is so unsophisticated as to believe that he stands any part of it, for every one knows that he at once cuts his workmen correspondingly and generally so that he gains a small fraction here and there to make his profit, if anything, greater than before. It may be asserted that contractors improve their tools and processes and thus cheapen the manufacture of their product. We admit that in one or two cases in our experience, some years ago, this was the case. But in these cases the tools were paid for by the employer, and the contractors were given the use of them free of expense, and only were required to produce them in inventory each year and at the termination of contracts. It cannot be expected in truth that a contractor would or could pay for many new tools, because he could not know that he would be awarded another contract at the expiration of the one existing when the tools were made. We know of one case where a contract for $1500 worth of work stated that all tools made to do work should be paid for by the contractor, but should become the property of the concern at the expiration of the contract without further remuneration. The tools in this case cost about $400, yet the contractor made a good profit, principally because the superintendents, not owners, who gave the contract were not industrious enough to get facts to base their calculations upon, but on the contrary merely guessed at the prices. When, however, a great profit was shown in favor of the contractor the cost of the tools which were made in the tool-room of the concern was recalculated and expanded so as to absorb all the objectionable profit and make a respectable showing on the books. Such treatment of contractors is very common, and discourages the building of all tools not certain to yield a good profit from a very small outlay. In many instances a contractor will fail to get a renewal because of an underbid, and the probability of this also discourages improvements in tools. Again, employers often remove a contractor for various causes, and in many cases after studying it they discontinue the system altogether. Hence there is but little encouragement to contractors to improve tools and processes, or in fact do anything after a "cut" but cut his workmen in turn.

WHAT an owning employer makes or saves by letting his work out to contractors is past finding out. It is possible that he may get his work cheaper than by day's work where his superintendence is careless or inexperienced, but that is doubtful in most cases. The loss he sustains, however, in giving contracts, rather than piece work direct to his workmen, is much greater than the profits gained by the contractor, because in this case there is every encouragement toward the improvement of tools and the processes of manufacture, and in this case also every one of the piece workers also is interested and gives many valuable suggestions to forward his interest as well as his employer's. Employers lose control of their men and their work where it is "contracted" out, and this leads to insubordination and to waste of materials. Every factory-owner whose work is done by contract knows that every effort he makes to get at the exact details of his work is circumvented, or he is given statements in which he has no confidence. Again, the percentage of material supplied compared to parts finished is too high when compared with other systems of manufacture. Every factory-owner that has his manufacturing done by contract, knows that his men are not loyal to him and that they dare not be so in preference to being true to their contracting superior. With the system of piece-work directly between the workmen and the owner, it is obvious that there is required more and better superintendence to fix just and equitable prices, to see that men actually work for what they get, and to inspect the production for quantity and for quality. But, under this system, the owner deals directly with his men to the benefit of both. His assistants, being salaried men, can be well paid with a fraction of the savings gained over day's work or the contract system. More proper discipline may be maintained and more proper freedom felt under the direct piece-work system than under any other wage system. The owner knows or can know just what his output will cost, and the men know that all extra efforts will increase their own earnings as well as the profits of their employers. Under this system it pays to be just and fair. No wise employer will cut a smart man's price who makes high wages any more than he will give a slow man an extra price so that his snail-pace shall not affect his pay. The prices should be set at the average and after they are permanently determined should be set for a year or until a change is made either in the construction of the piece or in the tools and method of its manufacture. Often a bright man will devise small tools or improve others so that his output is increased materially. In such cases he certainly is entitled to all the benefits derived from his ability until the expiration of the year or other time agreed upon, and even afterward he should receive a recognition for it.

THERE is really nothing to be said in favor of the contract system of manufacture except from the standpoint of the contractor. His position, like that of many another middleman, is more benefited by his removal than by being either sustained or instituted. The only excuse for his existence originally lay in the crude ideas of manufacture existing among owners before the era of improved tools such as jigs and special fixtures, by which work can be duplicated cheaply, expeditiously, and accurately. Within a period ending in the eastern United States about 1876, there were too few men capable of doing good work cheaply, and such men as were capable were in demand and could find situations on favorable terms to manufacture by contract, in quantities, work at prices that surprised their employers but which paid them well. This period now is past, for there are plenty of reasonably able men, known as toolmakers, who can devise and duplicate jigs and fixtures of standard design as well as any of the marvelous contractors who graduated from Colt's armory in its prime.

THE confidence with which foreign manufacturers accept American methods and machinery, and the uniformity with which this machinery satisfies that confidence by fulfilling the expectations of the buyers, is most gratifying to those who export as a business and to the engineers who design it, and it is a matter of pride and glory to the American people. Among the latest triumphs in this line is the adoption of the American system of kiln drying by some of the leading lumber people in Western Europe. This is not like the baking of wood in ovens as in the old system, but the forcing of a blast of hot air through the piles of lumber properly housed. In this way all the moist vapors evaporated from the wood are driven away by a current of dry atmosphere from fans operated by power. It is said that woods dried in this manner are improved in every way, that they are more evenly dried, and that the grain (which is the element of beauty in woods) is much improved by the process. The fact that it prevents checking would in itself be a sufficient advance over other methods of drying. I am indebted to the Buffalo Forge Co. for a letter from a foreign purchaser who writes: "The outfits were placed by our own hands, following your specifications, and we were not put to the expense of securing an expert for the purpose. The whole arrangement is very simple, and easily managed, besides being a money-saver in operation. We are able with the kiln you sent us to dry soft woods in three days, and hard wood in five days; that's good enough for any one." Testimony like this emphasizes the growing appreciation of American machinery in foreign markets.

"MR. BLUNT, we will have to get a new spindle for the thirty-inch lathe next the boring mill. I suppose we can order from the maker cheaper than we can make one."

"Headstock spindle?"

"Yes, sir."

"Isn't that the lathe the new chuck is for?"

"It is; yes, sir."

"What happened to it?"

"The new chuck needs a flange to fit it to the spindle. We found a suitable pattern and cast one yesterday. The man who was boring it out preparatory to cutting the thread in it, bored out the spindle also, so that when he had it almost to size the thin shell broke and the whole thing fell down on the shears of the lathe and rolled to the floor."

"One of my men did that! Who was it?"

"Mr. Means."

"Why was Mr. Means entrusted with such a job as that, Mr. De Gree?"

"He was anxious to do it, having done a similar operation at the Institute. He is willing to pay for the damage."

"Damage!" said Blunt,—accenting the first syllable;—"can he pay for the delay! That lathe was made by a concern now out of business, and we will have to make a spindle ourselves, and it will take four days, and another lathe from the work. Oh dear! Mr. De Gree, hereafter do not push forward any young man beyond his knowledge of the trade, no matter what his antecedents may have been. I cannot go to my customers with poor work and say to them: 'This is a botch job and I know it, but the young man who made it is a scion of one of our first families.' A customer would not stand that, he would tell me: 'What do I care who made this thing? If it is good I want it, but if it is bad I won't have it.' I am glad Mr. Means has the courage to be industrious and to get the trade practically by experience. I honor him for it. Of course I will not make him pay for the accident any more than any other boy working under instructions, but it will make us more careful what kind of jobs he receives."

CURRENT TECHNICAL LITERATURE

Resistance of Ships and Screw Propulsion. By D. W. Taylor, Naval Constructor, United States Navy. New York and London: Macmillan & Co. [Cloth. 8vo. 234 p. $3.75]

THE general purpose of this work is the development of formulæ and methods for the determination of resistance and indicated horse power, and for the design of screw propellers. Chapter I contains the treatment of the subject of resistance, embodying the duly credited results of Froude, Tidman, and others. As a result the author proposes a formula involving the 1.83ths and 4th powers of the speed, and two conditioned constants, precedents for the determination of which are given at a later point. In Chapter II the theory of the propeller is taken up. Propeller theories in general may be divided into two classes: (1) Those in which the quantities considered are the amount of water acted on, and the acceleration communicated to it, with the various velocities involved; (2) those in which the quantities considered are the geometry and velocities of the propeller, and the amount and distribution of pressure over its surface. Neither class of theory is satisfactory, for the reason that in (1) we cannot accurately determine either the amount of water acted on, or the acceleration communicated to it, and in (2) we cannot accurately determine the amount and distribution of the pressure. Propeller theories have usually been of the first class. The late William Froude in 1878, however, published in the transactions of the Institute of Naval Architects a paper outlining the basis for a theory from the second standpoint. No attempt was made to develop this into a working theory, and, with occasional reference by other writers, the subject so remained until the advent of the present work, wherein we find the theory from this standpoint carried out into working form.

The geometry is introduced by means of certain functions of form called characteristics. These are made independent of dimension, and their values for a proposed form of developed blade are tabulated for all usual ratios of diameter to mean width. It then becomes possible to express the performance of the propeller as a function of the dimensions, the velocities, the characteristics, and two conditioned constants. One of these is the tangential or frictional resistance per unit area, and the other the normal pressure or head resistance for the same unit. The application of these formulæ to the results of tests of propellers will then serve to furnish data for the necessary control of the constants, and the formulæ thus become appropriate to the design of propellers intended to work under conditions similar to those from which the data were drawn.

Chapter IV takes up the analysis of speed and power trials. The methods used are highly ingenious and original, and furnish an analysis in greater detail than by methods hitherto in use. The results obtained are as follows: The assumption and consequent elimination of the initial engine friction; the determination and elimination of the load engine friction; the determination of the power involved in the skin resistance; the determination of the power involved in the friction and resistance of the propeller; the determination of the power involved in the wave making resistance; the determination of the amounts of power involved in the thrust deduction and wake gain; the wake factor and the various efficiencies also appear in the process of analysis.

Chapter V takes up the powering of ships. The various approximate methods are explained and their limitations noted. Froude's extended law of comparison is then fully explained, and tables and diagrams for its ready use are provided. The author gives also what is termed an independent estimate method, involving the use of the formula for resistance deduced in Chapter I, and certain assumptions as to the efficiency of engine and propeller.

The author is unnecessarily severe on the admiralty $D^{2/3}$ constant method, and on other similar methods involving an area function of the ship, and the cube of the speed. It is readily shown that if the constants are taken as *equal* for *similar* ships at *corresponding* speeds, the law of extended comparison is exactly fulfilled, and the same results are obtained as by its use in the form recommended by the author. The selection of the constants in this way is in fact simply one form of the many in which this law may be put.

In Chapter VI the design of a propeller is shown in detail, and additional characteristics are derived by means of which the stress on the root of the blade may be determined, and the design for strength effected.

As a whole this work marks a distinct advance in our knowledge of the subject, and in our means for the treatment of the various problems of design. From the free use of analytical methods it is a work which will most strongly appeal to those interested in the mathematical and theoretical development of the subject. The practical applications are put in such form, however, that no especial knowledge of higher mathematics is necessary for their execution. Throughout the work, moreover, tables are freely provided as aids in the practical carrying out of the operations involved.

The reliability of these methods and their general superiority over those more commonly in use involves a question which can only be determined after a considerable amount and range of application. In general these methods involve a greater number of variables than those now in use, and we should therefore expect that with equally good control for the constants involved, they would give more accurate results.

In any case it must not be forgotten that when formulæ and methods involve the use of constants whose value must be controlled by the results of actual experiment, the use of such formula or method beyond the range covered by the experimental data is accompanied with uncertainty, and should be avoided. It follows likewise that the longer such formula or method is used, and the more data there is available for its control, the more trustworthy will be the results obtained by its use.

W. F. DURAND.

THE COAL AND METAL MINERS' POCKET-BOOK OF PRINCIPLES, Rules, Formulæ and Tables, specially compiled and prepared for the convenient use of mine officials, mining engineers, and students preparing themselves for certificates of competency as mine inspectors or mine foremen. Fifth edition. Revised and enlarged. Illustrated. Scranton, Pa.: Colliery Engineer Co. [Cloth. 12 mo. 565 p. $20.]

THIS pocket-book corresponds in the main to Trautwine's and Haswell's civil engineering pocket-books, giving much of the common-stock material that is applicable in all branches of engineering, omitting that which does not so apply in mining, and adding features of special interest and utility to mining engineers that are not given at all in other compilations of its class. The departure in method consists in the introduction of a relatively large amount of reading matter, so that the work is not merely a collection of tables and formulæ, but, in part at least, serves as a descriptive treatise.

The chapters on mathematics and mine-surveying which occupy the first 74 pages are admirable in point of simplicity and clearness, and are amply sufficient for the everyday requirements in mine work. It might be advisable to add a special section on the class of surface work performed in locating mine boundaries and establishing them when applying for United States patent on mineral ground, as is done by the United States deputy mineral surveyors. For the refinements of surveying, as in running long and difficult tunnel connections, something more is needed than space allows. But the omission of such points simplifies the subject for the ordinary use of the miner. The tables of weights, measures, money, strength and weight of materials, etc., are of the usual form. The chapters on wire ropes and chains are very complete. A short section is devoted to the principles of mechanics.

The chapter on colliery management is the most important feature of the work; and that portion of it on "Methods of Working" contributed by Mr. W. S. Gresley, is of especial value from its logical exposition of different systems as applied under varying conditions. This is really a monograph in itself. Ventilation, as might be expected in a work intended chiefly for coal-miners, is treated in much detail and with thoroughness. Then follow chapters on hydrostatics, hydraulics, compressed-air power-transmission, mine railways, friction of mine cars, colliery machinery, steam raising, etc. Under the head of miscellaneous are included a variety of data, location of mine faults, application of electricity in coal mining (which, by the way, is hardly up to date), glossary of mining terms, and trigonometric and logarithmic tables.

Whatever weakness may exist in the formulæ and tables can only be developed in the course of practical use, and cannot be detected on a cursory examination. The careful editing and the general excellence of the typography lead one to hope that the type-setting and proof-reading may be depended upon—a most essential point; for nothing is more vexatious than to run across an error in a figure or equation when referring to a work which has often to be trusted to as the court of last resort.

Those who have had frequent occasion to use any of the engineering pocket-books cannot have failed to remark one exasperating peculiarity, which seems to be inevitable no matter what pains have been taken by the compilers to make them complete; and that is that the one particular thing that it is desired to find out, in order to solve the actual problem in hand, is just the thing missing, while any amount of irrelevant or almost irrelevant matter is liberally bestowed. This is something that cannot be altogether avoided. The best that the compilers can do, if they understand the practical requirements (as the compilers of the volume under notice seem to do), is to keep in mind what the user will be most likely to seek for, and to provide for all reasonably probable emergencies. In the present case, so far as can be judged by a brief inspection, the selection of material appears to have been made judiciously and with a view to the real needs of the user. Within certain limitations as to scope, a fair degree of completeness has been reached. The compilers cannot be expected to condense a library within 565 pages, and they evidently have not padded out with matter simply to make a plausible looking book, but have shown discretion in pruning off much of the useless matter which so often encumbers reference books, in order to make room for what is of value. Miners, as a rule, do not need to go very deeply into the refinements of engineering, but they require information of a kind that is distinct and apart, at the same time having to trench somewhat upon the ground belonging to the civil and mechanical engineers.

It may seem captious to find fault with a work so excellent in other respects, but in common honesty exception must be taken to the statement in the preface that "metal mining is treated as comprehensively as coal-mining." The fact is that there are just eleven pages (pp. 182–192) devoted to metal mining proper. Incidentally, of course, some of the matter regarding colliery work applies to metal mining as well, and this is true also of the sections on mathematics, physics, machinery and some miscellaneous data. But the compilers, doubtless influenced by the local environment, have devoted their energies mostly toward meeting the requirements of coal-miners, and this has resulted in crowding out and slighting an equally important division of the subject as indicated in the title. The problems in metal mining may not be more difficult or urgent than those presented in coal mining, but they assuredly are more complex and variable, the conditions being so much more diverse.

Advantage may be taken here of the polite invitation of the publishers to "call attention to the omission of any data that they [readers and users] may have felt the want of, so that it may be inserted in future editions," to venture a suggestion or two. It would not add much to the bulk and the cost of the Pocket-Book to insert concisely prepared sections on: Rocks, their composition, character, relations to ore deposits, behavior in drilling, blasting, as building material, etc.; minerals, composition and determination of the few principal ore and gangue minerals (physical; chemical, and blowpipe tests for the useful minerals and mineral substances); working of quarries; well-boring and location of petroleum, brine, gas and artesian wells; hydraulic and other varieties of placer mining (for which there are rules and formulæ available); explosives; systems of blasting; power drills; locating adit and drainage tunnels; without going into metallurgy proper, to give the underlying principles of ore dressing (classification and concentration), as a preparation at the mine for further treatment; mine accounts; forms of superintendents', inspectors,' and experts' reports; bibliography of standard technical literature bearing upon mining, etc. The book could stand an additional hundred pages without becoming too bulky, being printed on extra thin paper.

ALBERT WILLIAMS, JR.

CONTINUOUS CURRENT DYNAMOS AND MOTORS: THEIR Theory, Design, and Testing. With Sections on Indicator Diagrams, Properties of Saturated Steam Belting, Calculations, Etc. An Elementary Treatise for Students. By Frank P. Cox, B. S. New York: The W. J. Johnston Co., Limited. [Cloth. 12mo. Illustrated. 271 p. $2]

THIS is a new text-book upon a subject of prime interest both to students in electricity and to electrical artisans and one upon a knowledge of which more depends in the successful handling of electrical machinery than at first sight appears. It has been long held by the reviewer that an apparatus cannot be intelligently handled until the operator thoroughly understands its construction and the part which each element in the apparatus plays in the economy of the whole. While our best treatises on this subject could offer nothing better for a long time than a collection of empirical formulæ and "rules of thumb," the science of electricity and magnetism has so far advanced within the past few years as to enable us to substitute scientific methods for empiricism, and we now have a number of treatises which develop these subjects by rational methods. Most of these, however, are for the advanced student or specialist and involve a knowledge of the higher mathematics, which at once places them beyond the reach of those not thus equipped. With few exceptions, all attempts to popularize these subjects, to bring them within the reach of a larger circle, have failed, at least in part, because the author, in attempting to break away from the more scientific nomenclature of the mathematical treatises, has also in a measure departed from scientific methods.

In the present volume the author has very successfully maintained a medium course and has given us the best that has thus far been published for the classes intended to be reached. Mr. Cox impresses one with the idea that he is practically familiar with the subject of which he treats and gains the confidence of his reader at once. To a charming style is added that very rare ability to impart to others the knowledge which he possesses; his explanations are clear and concise and divested of all useless verbiage. His method, too, is the approved one, viz., strictly scientific and mathematical, relying for simplification solely upon clearness of diction and a strict adherence to the object in view.

The book is by no means intended for the first beginner, but presupposes a more than speaking acquaintance with electricity in general and motors and dynamos in particular, and a mind already trained to mathematical analysis and synthesis as expounded in algebra and geometry.

The first four chapters are devoted to a brief review of the electrical units and the general principles of the machines, and may be considered as an introduction to the subsequent portions. With the fifth chapter commences the mathematical discussion which leads to the determination of the various dimensions. The criticism upon this is that it seems at first a little abrupt by contrast with the purely descriptive matter which precedes it, but this is only apparent, however. With Chapter VI the difficulties experienced at the first plunge into mathematics are cleared away, and from this point on the reasoning in general seems exceedingly clear and logical and will be followed without difficulty. Throughout the book the author has recognized the fact that some minds are more receptive to one method of reasoning than another and where admissible, he has given more than one method of reaching results. Thus in Chapter V he gives both Kapp's and J. E. Hopkinson's method of determining the magnetic circuit, and in Chapter VII, under the head of the dynamo as a motor he gives two methods of equating for torque. With Chapter VII ends the discussion of generators and motors in the abstract, and with Chapter VIII begins the illustration of the previously enunciated principles by their application to concrete examples. The author has been particularly happy in his methods here. Starting with the problem to design a 200 light dynamo with difference of potential of 110 volts at speed of 1500 revolutions, without further limitations, he follows out both the mental and mathematical processes by which the desired result is reached, first for two pole and then for a four pole fields with Siemens and Gramme armatures, thus showing side by side how identical results are obtainable by the different methods now commonly in use.

In Chapter X the design of motors is discussed in an equally intelligent manner. Chapters XI and XII are respectively devoted to dynamo and motor testing and efficiency tests, concluding with these the purely electrical part of the treatise. Two more chapters and four appendices devoted to correlative subjects, viz., steam engine calculations, tests on iron, ampere turntable, determination of sizes of wire and belting, complete this excellent little treatise.

In his definitions alone is the author open to censure. In these he seems to have been especially careless. As examples of this may be cited the definition of the unit of weight (p.9), which he gives "as the weight of a cubic centimeter of distilled water at 4° C.";—he should have added "weighed at Paris." The volt, which he defines as that electromotive force which will be generated in a conductor moving in a unit magnetic field with a velocity of 100,000,000 centimeters per second, apparently forgetting that a wire may be thus moved and generate any electromotive force between the limits of 1 and 0. The book was evidently in press before the late Electrical Congress, as the new unit of self-induction, the heury, is neither defined nor mentioned. With the above corrections and a few others the book is an entirely safe one to place in the hands of the student, and its extended adoption as a text book in schools is confidently predicted.

NELSON W. PERRY.

NEW BOOKS OF THE MONTH.

Bartlett, Wallace A.=A Digest of Trade Marks Registered in the United States. For machines, metals, jewelry, and the hardware and allied trades, with a synopsis of the law and practice relating to trade marks. Washington: Gibson Brothers. [8vo, 190 p., cloth, $2.50.]

Benson, W. A. S.=Elements of Handicraft and Design. New York: Macmillan & Co. [12mo, 151 p., $1.60.]

Bent, B. J. Theodore.=The Ruined Cities of Mashonaland. Being a record of excavation and exploration in 1891, with a chapter on the orientation and mensuration of the temples, by R. M. W. Swan. New York: Longmans, Green & Co. [8vo, 328 p., ill., cloth, $2.50.]

Brooks, Francis A.=Objections Legal and Practical to Our National Currency System, Boston: G. B. Reed. [8vo, 56 p., pap., 25 cents]

Bose, T.=Practical Treatise on the Strength of Materials, including their Elasticity and Resistance to Impact. New York: Spon & Chamberlain. [8vo, 525 p., cloth, $7.25.]

Burn, R. S.=The Illustrated Architectural Engineering and Mechanical Drawing-Book. for the Use of Students and Artisans. Corrected edition, with new matter. New York: Ward, Lock & Bowden. [8vo, 155 p., cloth, 75 cents.]

Cooke, C. J. Bowen.=British Locomotives. Their history, construction and modern development. New York: Macmillan & Co. [12mo, 381 p., cloth, $2.]

Drake, S. Adams.=Our Colonial Homes. Boston: Lee & Shepard. [8vo, 215 p., ill., cloth, $2.50.]

Hazlitt, W. Carew.=The Coinage of the European Continent. With an introduction and catalogues of mints, denominations, and rulers. New York: Macmillan & Co. [8vo, 570 p., cloth, $5.]

Haeder, Herman.=Handbook on the Steam-Engine. With special reference to small and medium-sized engines, for the use of engine-makers, mechanical draughtsmen, and users of steam power. From the German by H. P. Powles. New York: D. Van Nostrand Co. [12mo, 446 p., cloth, $3.]

Hubert, Philip G., Jr.=Inventors. New York: C. Scribner's Sons. [8vo, 300 p., $2.]

Jackson, Dugald C.=Text-Book on Electro-Magnetism and the Construction of Dynamos. V. 1. New York: Macmillan & Co. [12mo, 281 p., cloth, $2.25.]

Johnson, Emory R.=Inland Waterways, Their Relation to Transportation. Philadelphia: American Academy of Political and Social Science. [8vo, 166 p., paper $1.]

Loewinson-Lessing, F. *compiler.*=Tables for the Determination of the Rock-Forming Minerals. From the Russian, by J. W. Gregory; with a chapter on the petrological microscope by G. A. J. Cole. New York: Macmillan & Co. [8vo, 55 p., cloth, $1.]

Love, A. E. H.=Treatise on the Mathematical Theory of Elasticity, v. 2. New York: Macmillan & Co. [8vo, 327 p., cloth, $3.]

Lewis, G. H.=National Consolidation of the Railways of the United States. New York: Dodd, Mead & Co. [12mo, 342 p., cloth, $1.50.]

Macleod, H. Dunning.=Theory and Practice of Banking. New York: Longmans, Green & Co. [8vo, 240 p., cloth, $5.]

Mayet, P.=Agricultural Insurance. In organic connection with savings banks, land credit, and the commutation of debts. From the German, by Rev. Arthur Lloyd. New York: Macmillan & Co. [8vo, 388 p., cloth, $3.50.]

McKinney, W. M. *editor.*=American and English Railroad Cases. A collection of all the railroad cases in the courts of last resort in America and England. Northport, N. Y.: E. Thompson Co. [8vo, 68 p, shp., $4.50.]

Morris, W.=Arts and Crafts. Essays by members of the Arts and Crafts Exhibition Society. New York: C. Scribner's Sons. [8vo, cloth, $2.50.]

Preece, W. H.=A Manual of Telephony. New York: Macmillan & Co. [12mo, cloth, $4.50.]

Ruskin, J.=The Elements of Drawing. In three letters to beginners. New York: Maynard, Merrill & Co. [12mo, 417 p., cloth, $1.50.]

Salomons, Sir D.=Electric Light Installations. Vol. 1. The management of accumulators: a practical hand book. New York: D. Van Nostrand Co. [12mo, 170 p., cloth, $1.50.]

Spalding, F. P.=Note on the Testing and Use of Hydraulic Cement. Ithaca, N. Y.: Andrews & Church. [16mo, 1113 p., cloth, $1.]

Smeaton, J.=Plumbing and Drainage, Water Supply and Hot-Water Fitting. New York: Spon & Chamberlain. [8vo, cloth, 236 p., $3.]

Taylor, D. W.=The Resistance of Ships and Screw Propulsion. New York: Macmillan & Co. [8vo, cloth, $3.75.]

Todhunter, I.=History of the Theory of Elasticity and of the Strength of Materials from Galilei to the Present Time. Edited by K. Pearson. V. 2 Pts. 1 and 2. New York: Macmillan & Co. [8vo, cloth, $7.50.]

United States, State Department.=Bureau of American Republics. Bulletin No. 55. Bolivia. Mines, trade routes, patents, population, etc. Washington: Government Printing Office. [8vo, 420 p.]

Ziwet, Alex.=An Elementary Treatise on Theoretical Mechanics. Pt. 1.—Kinematics. New York: Macmillan & Co. [8vo, 181 p., cloth, $2.25.]

Campbell, Helen.=Women Wage-Earners; Their Past, Present, and Future, with an introduction by R. T. Ely. Boston: Roberts Brothers. [12mo, 318 p., cloth, $1.]

NEW TRADE CATALOGUES.

Any of these catalogues free on application to the manufacturers.

The Field Engineering Company, New York. =Vertical Multi-Cylinder Engines for Electric Service. 30 p. [Illustration and description of engines capable of carrying loads continuously under extreme conditions and showing the highest economy for that service, whether lighting, railway, or power.]

Industrial Works, Bay City, Mich.=Cranes and Special Railway Appliances. 107 p. [I.—Cranes for railroad uses. II.—Steam excavators, railroad pile driver, transfer tables, portable steel rail saw.]

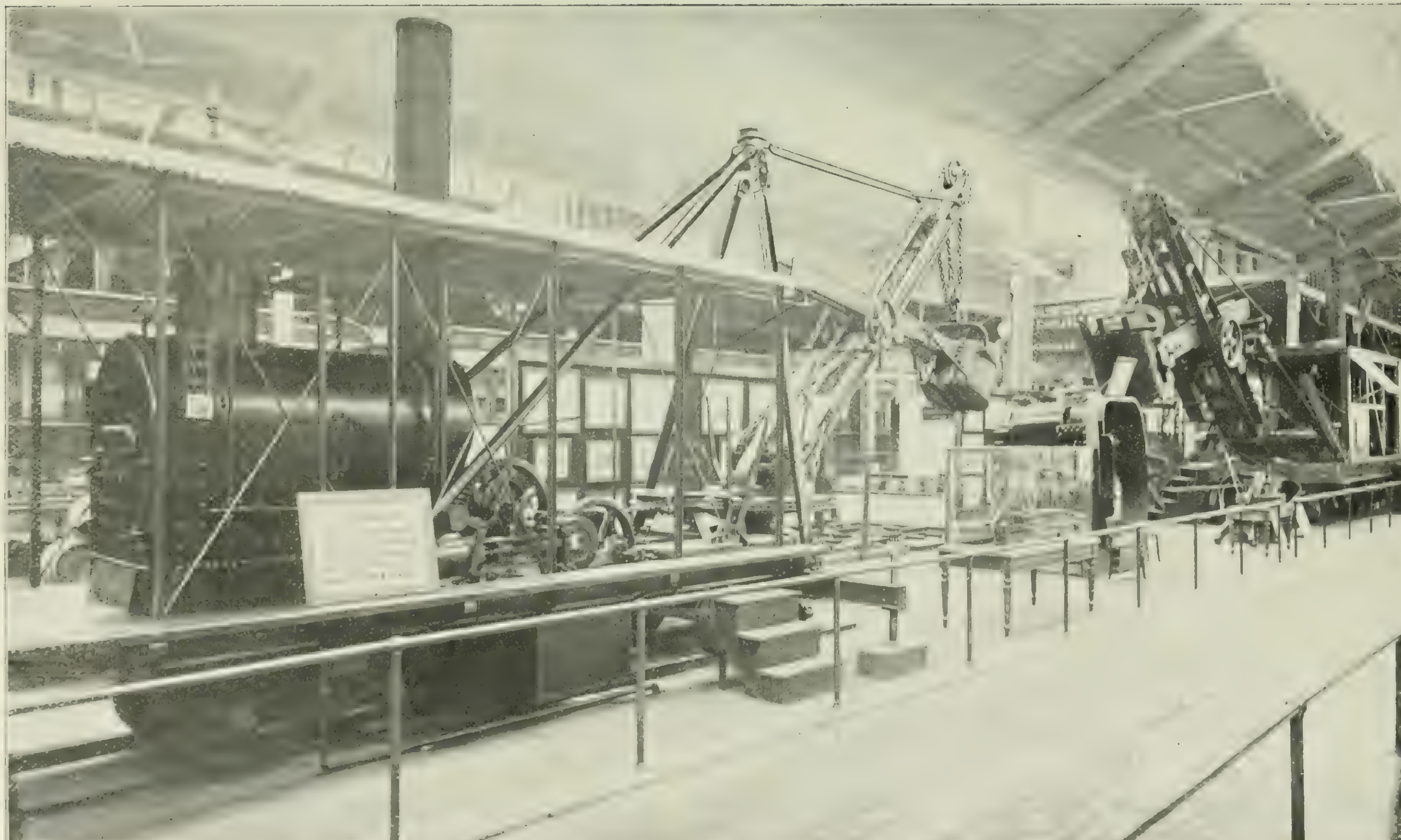
Builders' Iron Foundry, Providence, R. I.= The Venturi Meter. [Named after the Italian philosopher who first called attention to the relation between the movement and pressures of fluids when flowing through converging and diverging tubes, and consists of two parts, the tube, through which the water flows, and the recorder, which registers the quantity of water that passes through the tube.]

Alonzo C. Mather, Chicago.=The Practical Thoughts of a Business man. 88 p. [Successful enterprises organized by and on patents granted to the author, the author's undeveloped patents and possibilities; with chapters on such general subjects as unrestricted trade between Canada and the United States, proposed New York and Chicago electric system of transportation, three-rail tracks, etc.]

The Cincinnati Milling Machine Co., Cincinnati.=New Universal Cutter and Tool Grinder. 24 p. [Differs from other machines in the fact that it will grind any cutter and reamer without the use of special attachments, and that all work is done on a horizontal slide; also arranged for grinding cylindrical, conical, and flat surfaces.]

John P. Lovell Arms Co., Boston.=Lovell Diamond Cycles, 48 p. [Illustrating and describing the New Roadster, Light Roadster, New Ladies' Wheel, and the bicycles speed, strength and grace claimed.]

The Edward P. Allis Company, Milwaukee.= Reynolds' Quadruple Expansion Engine, 14 p. [The representative engine of the Exposition, more than twice as powerful as the Centennial Corliss engine. Maximum capacity from 3000 to 4000 H.-P.]



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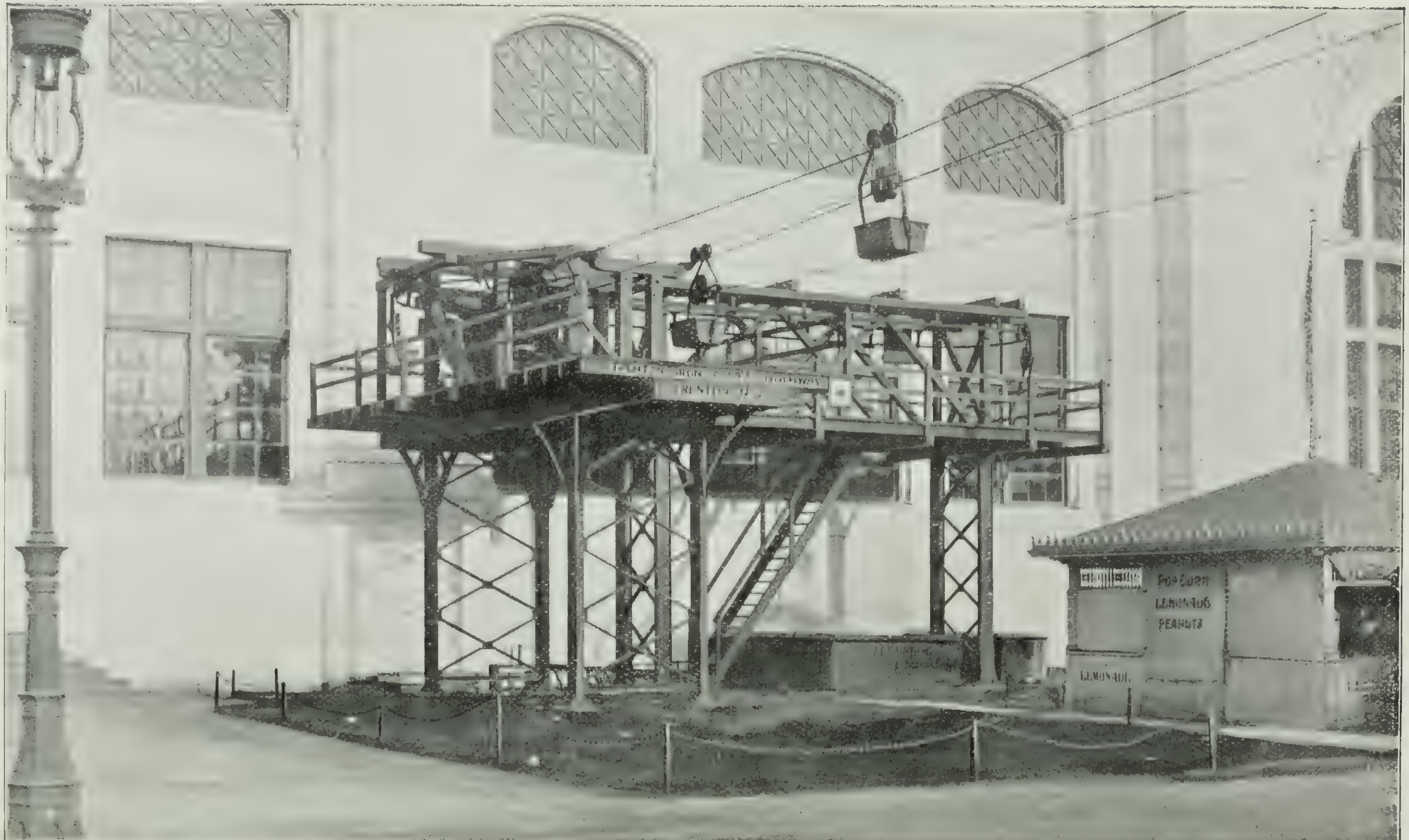

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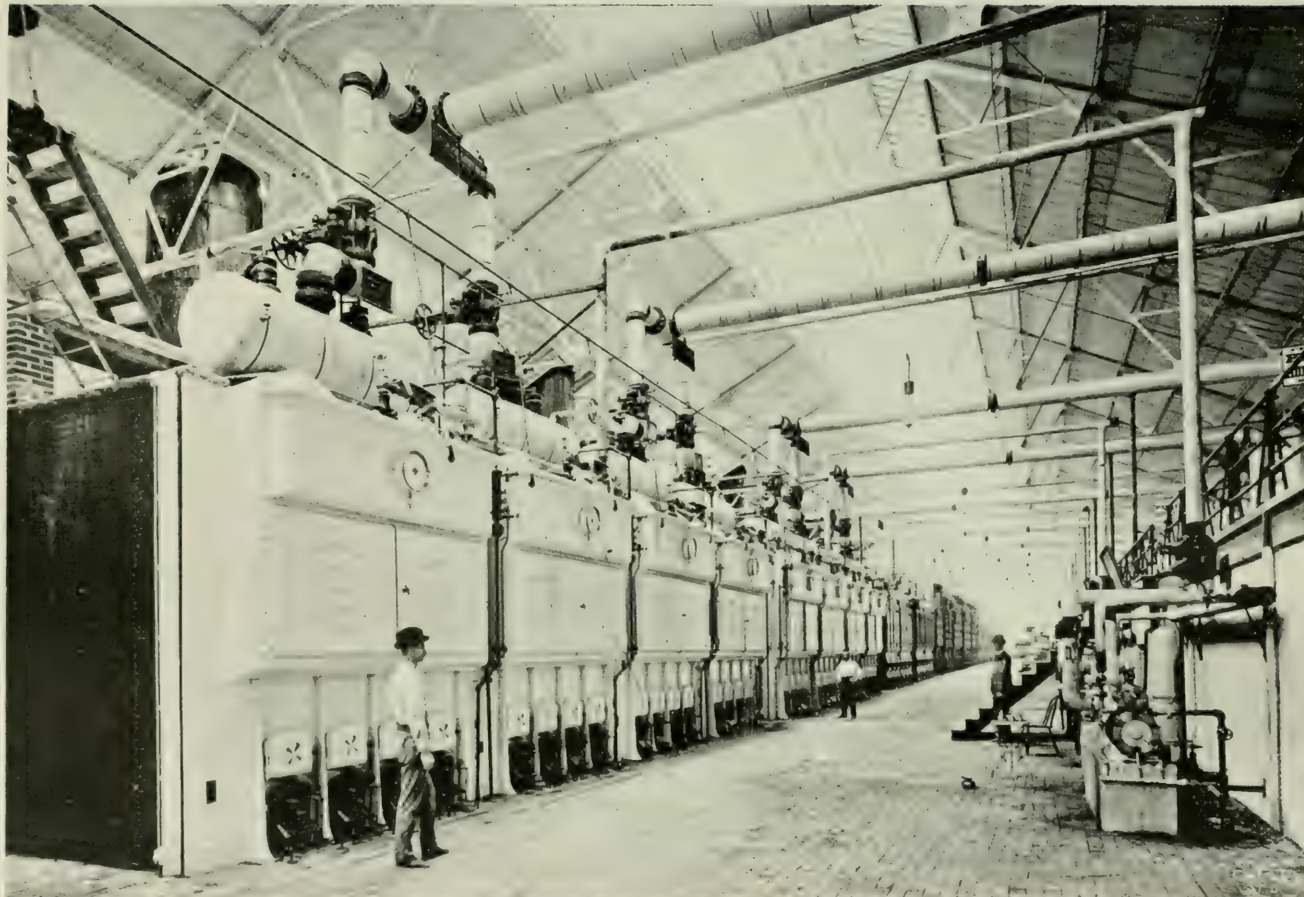

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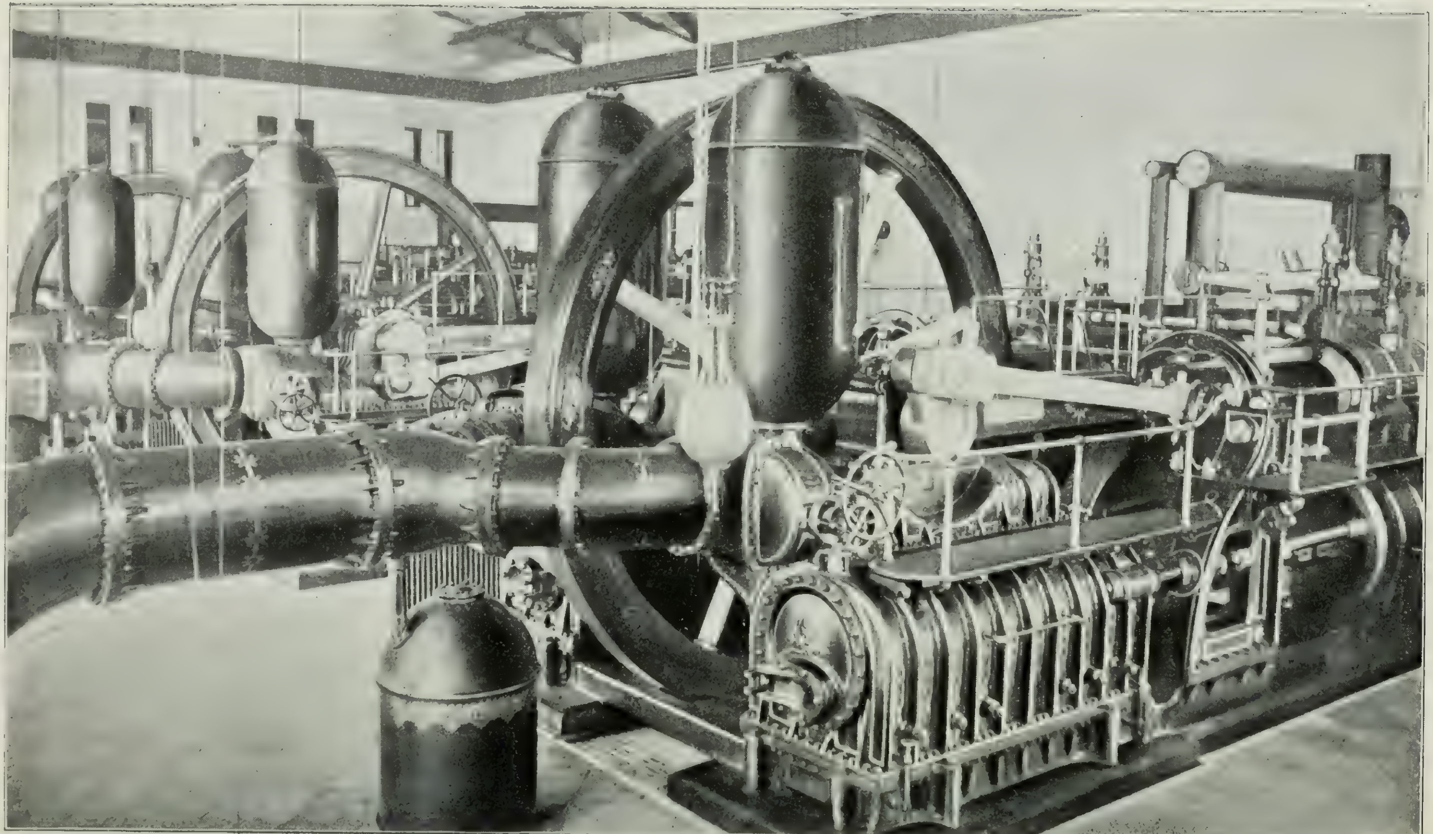

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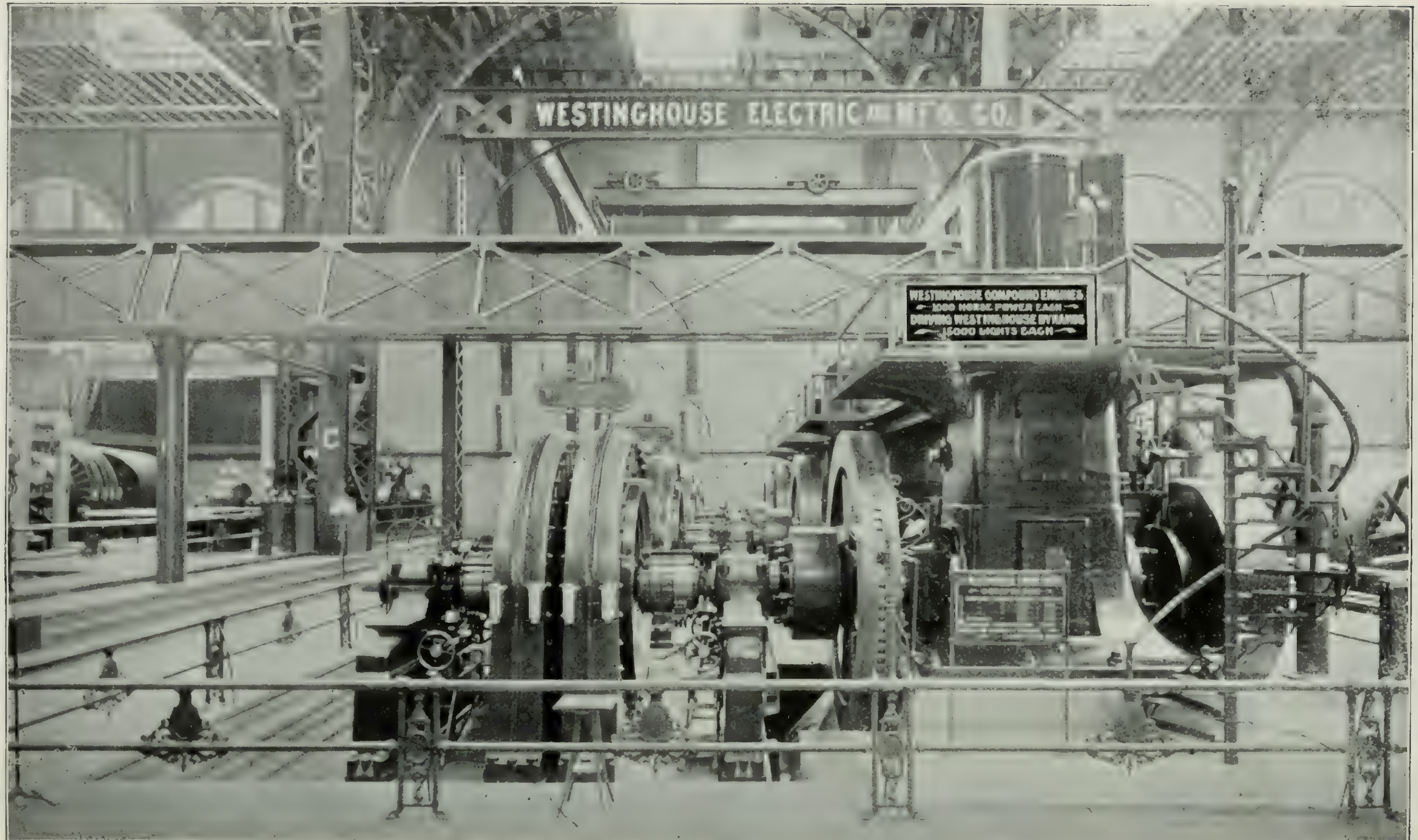

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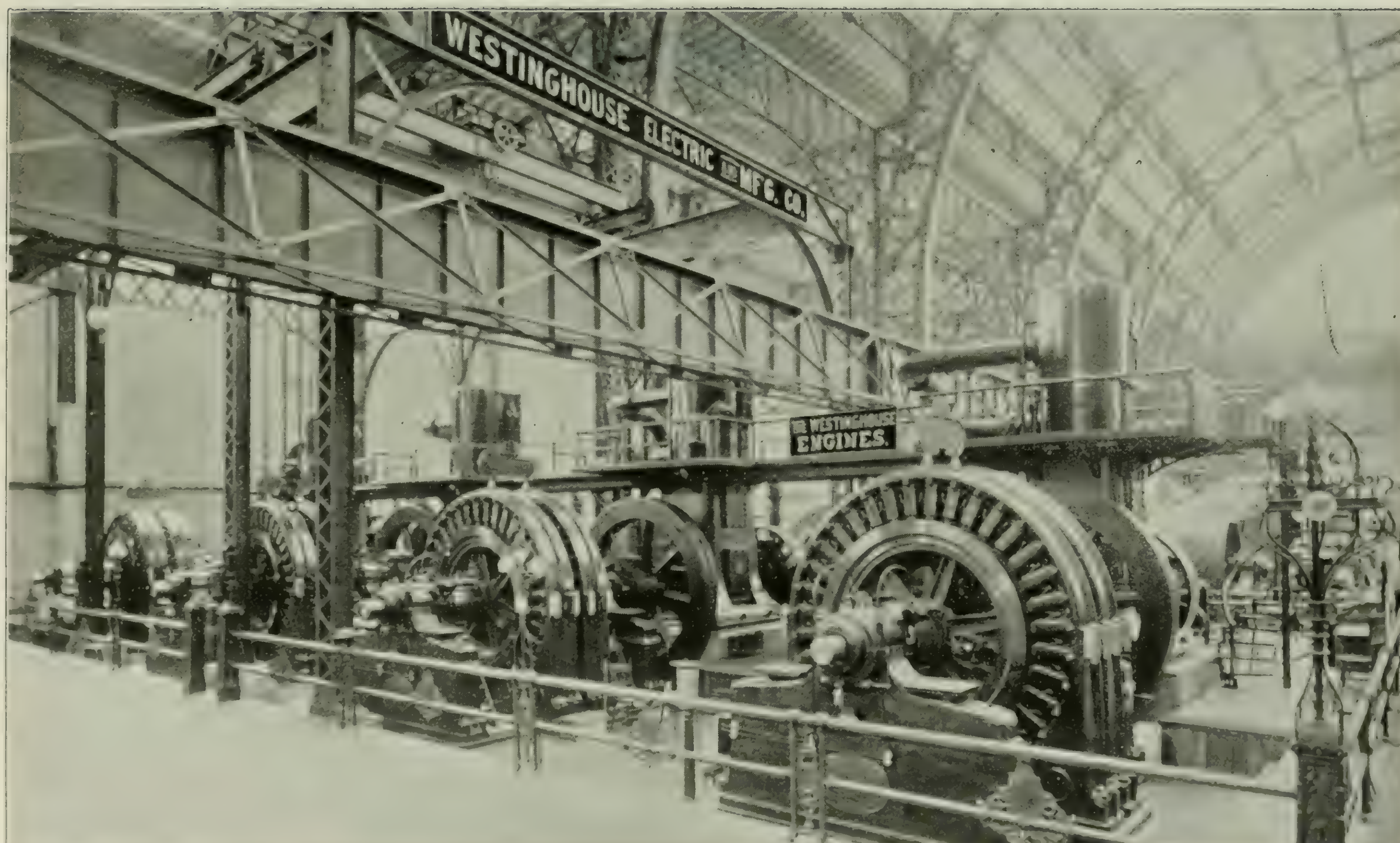

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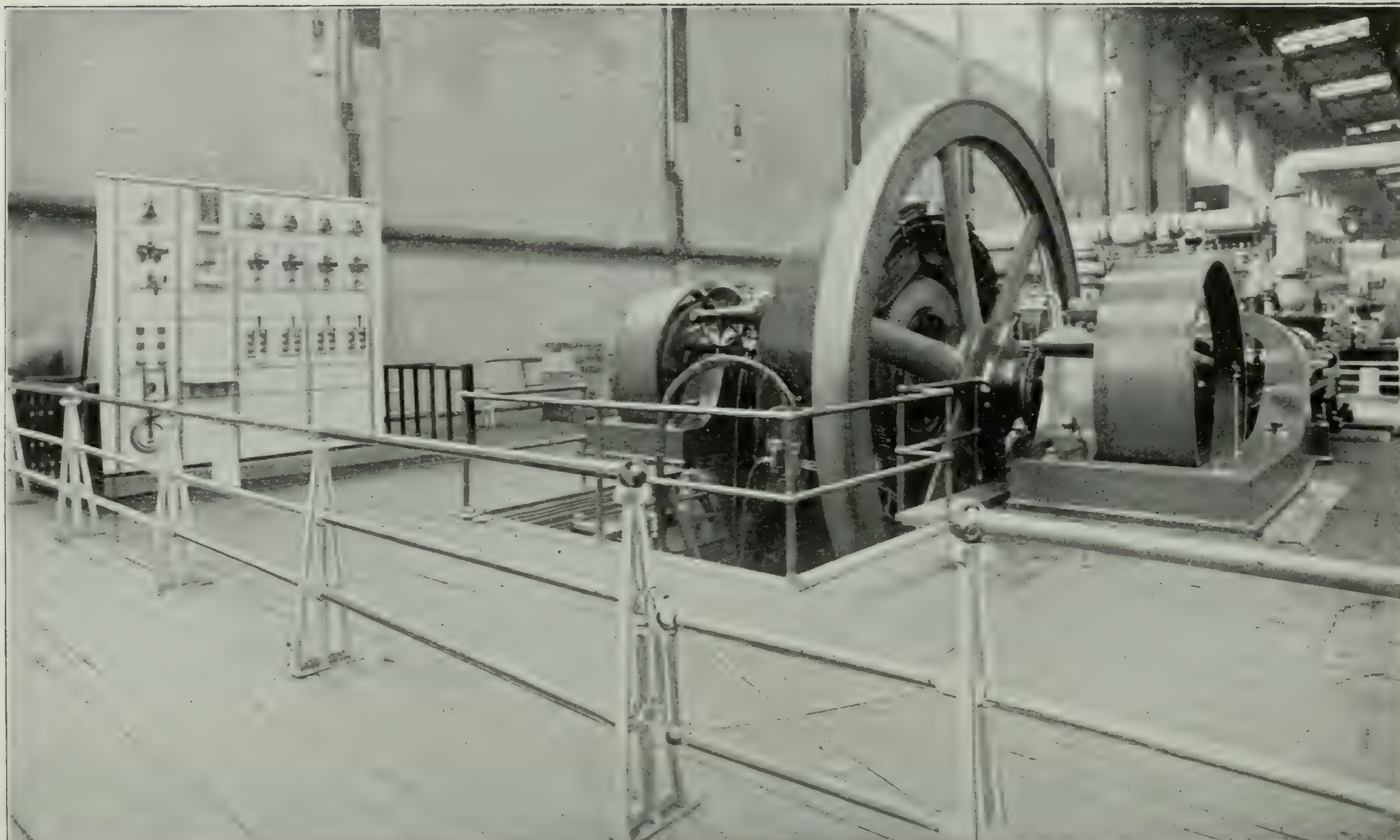
Side view of the four 15,000 light Westinghouse Dynamos, with the 1000 H. P. Westinghouse Engines in the background.



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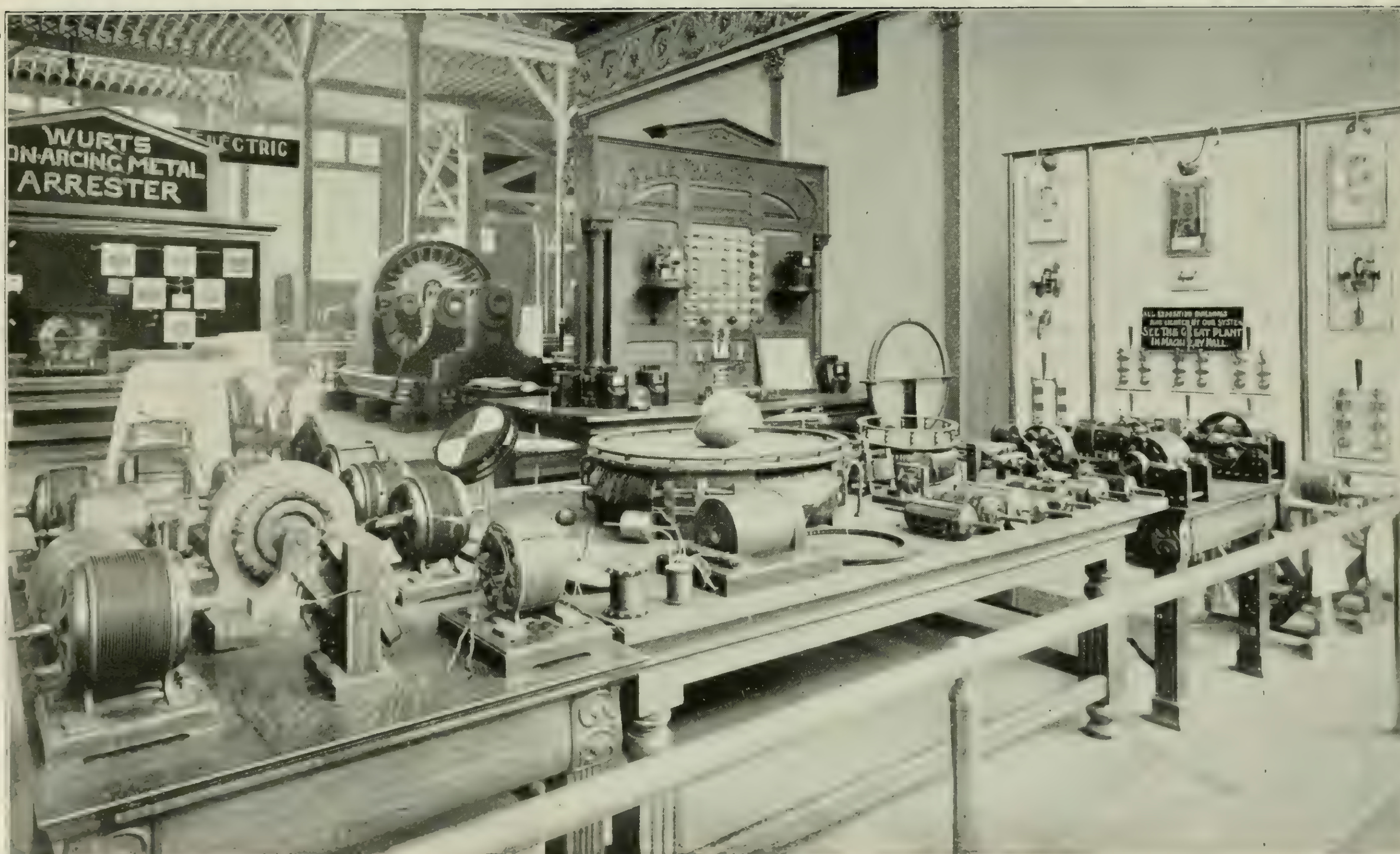
End view of the 750 H. P. 500 volt Power Generator. Connected direct to the Cross Compound Allis Engine; Switchboard for the Generator to the left.



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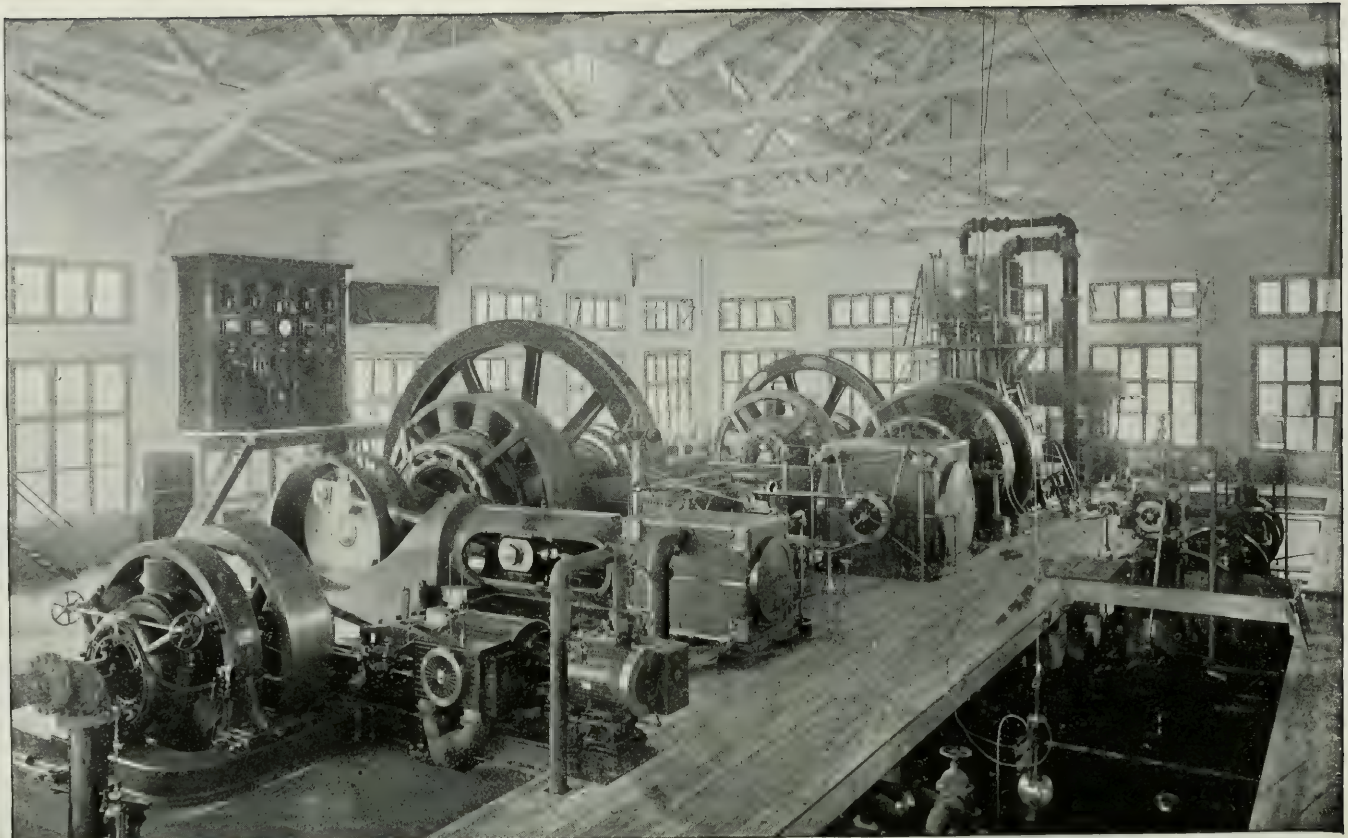

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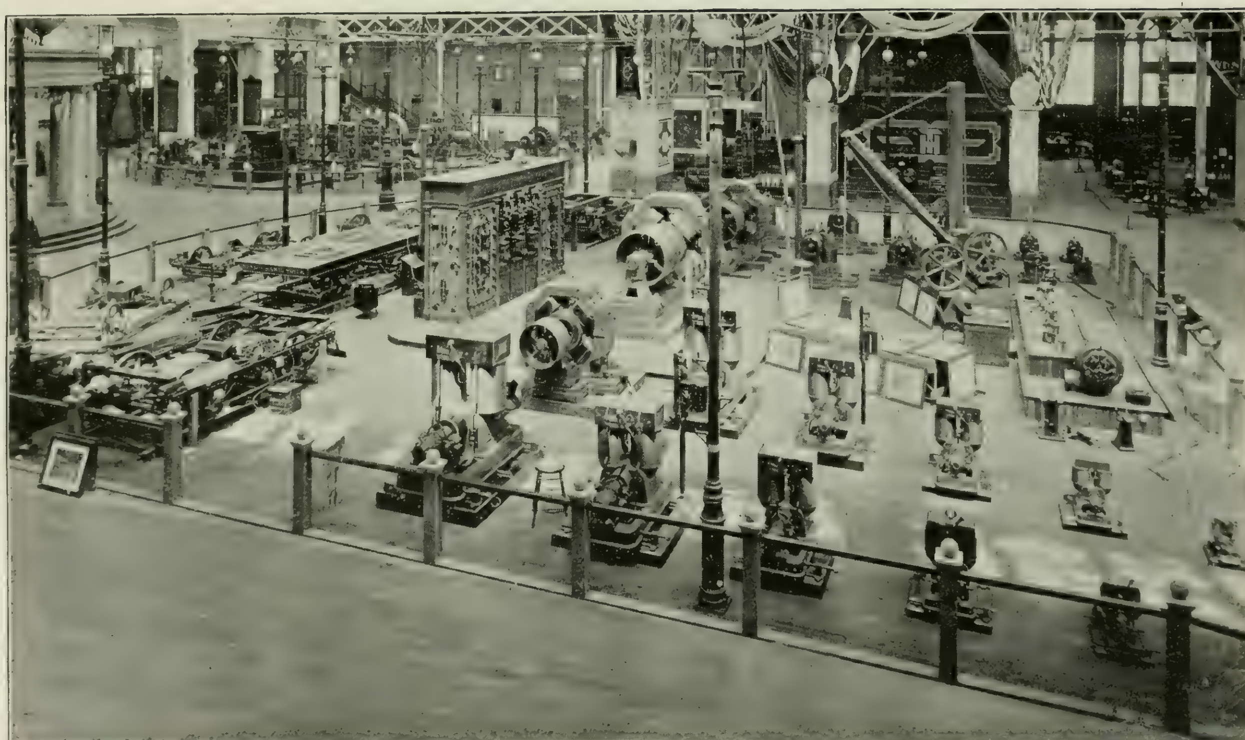

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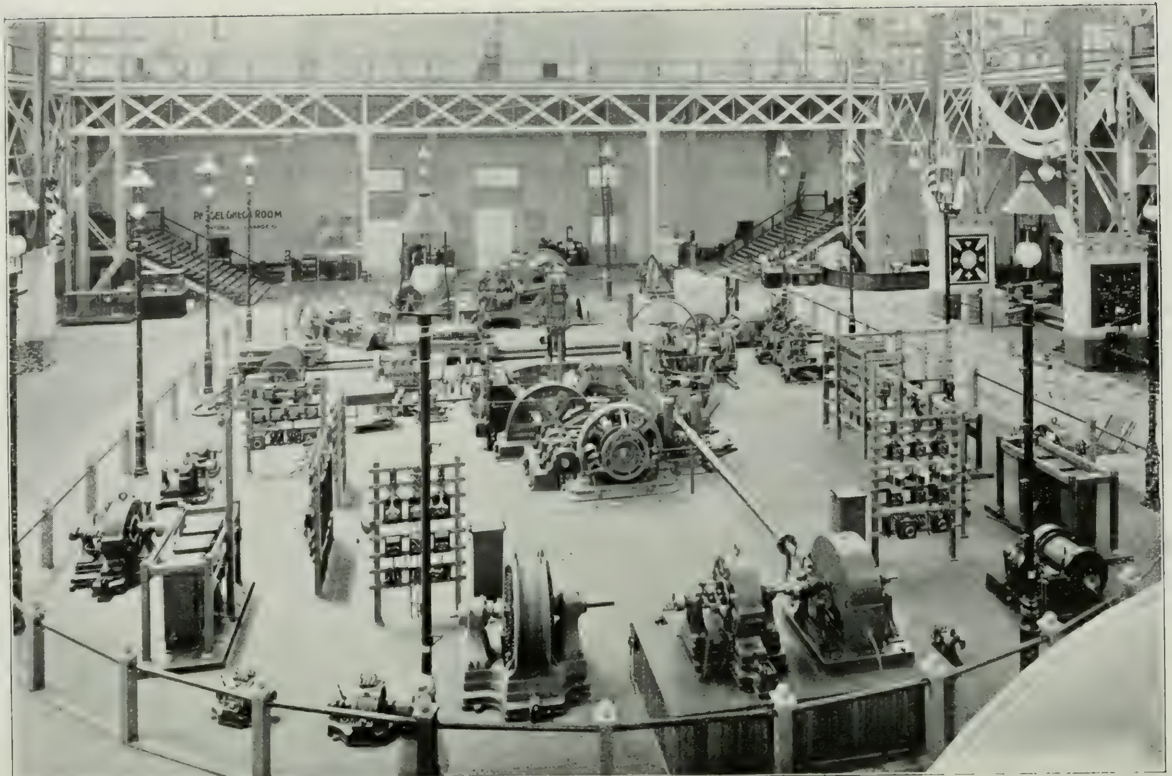

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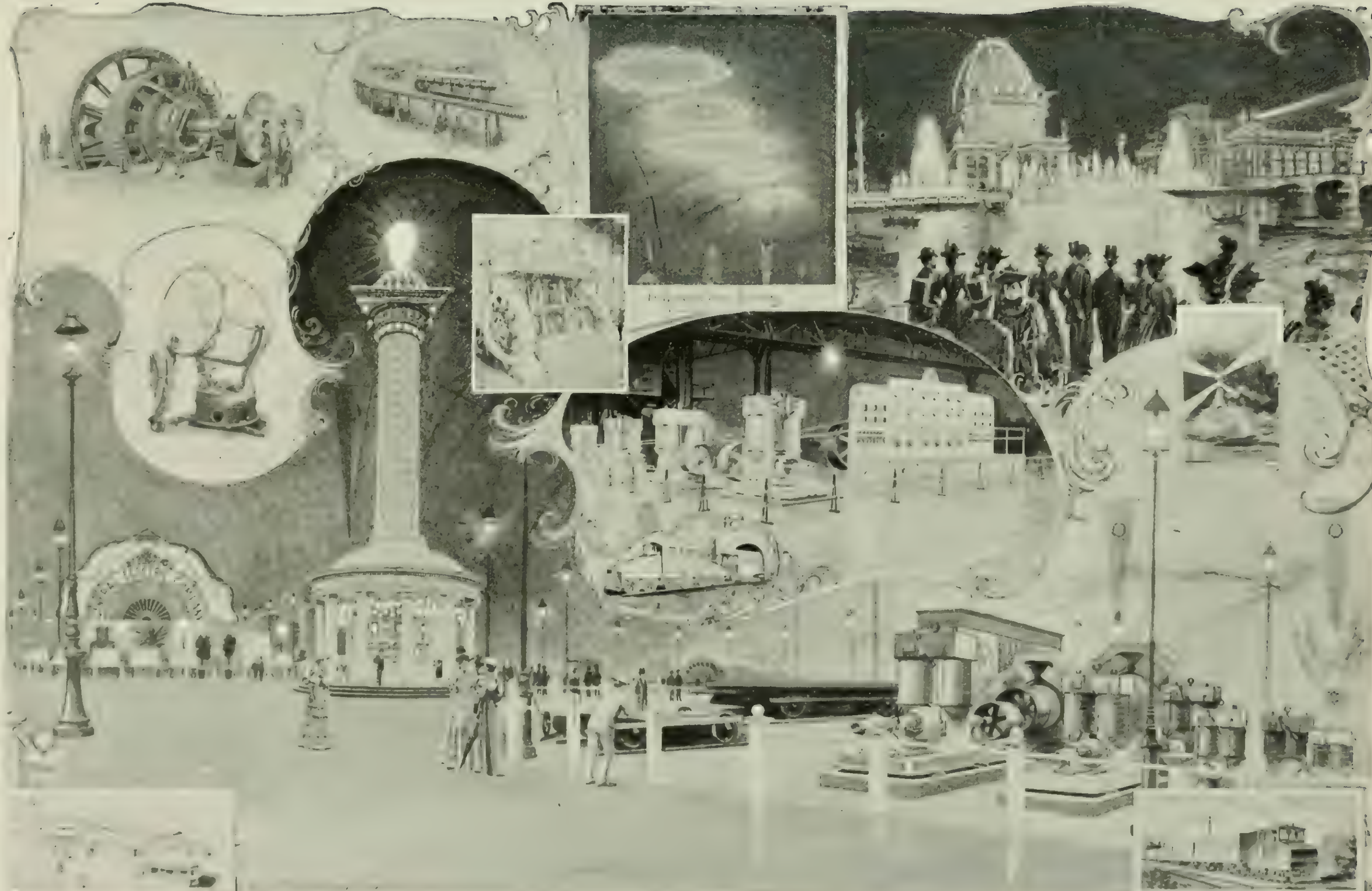

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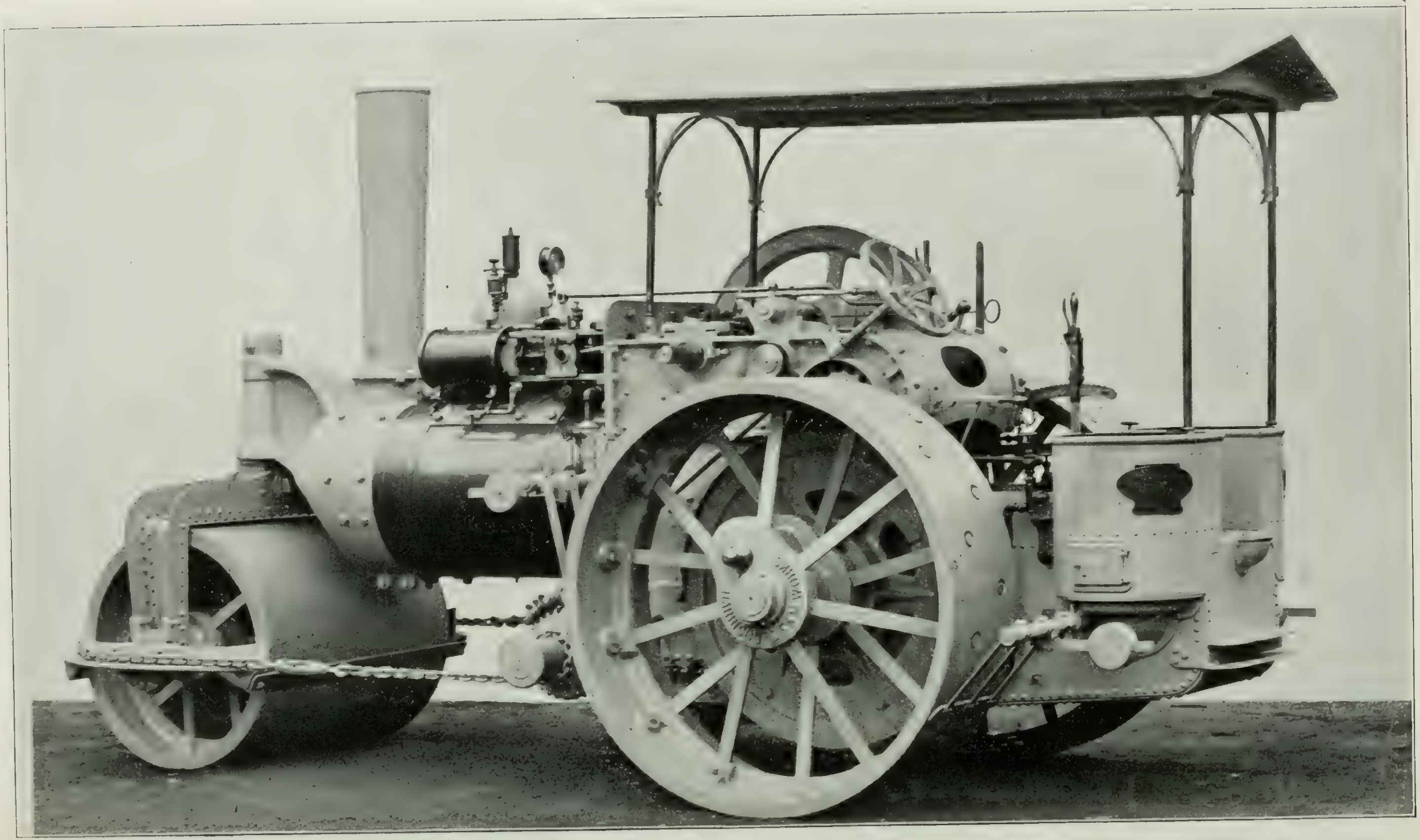
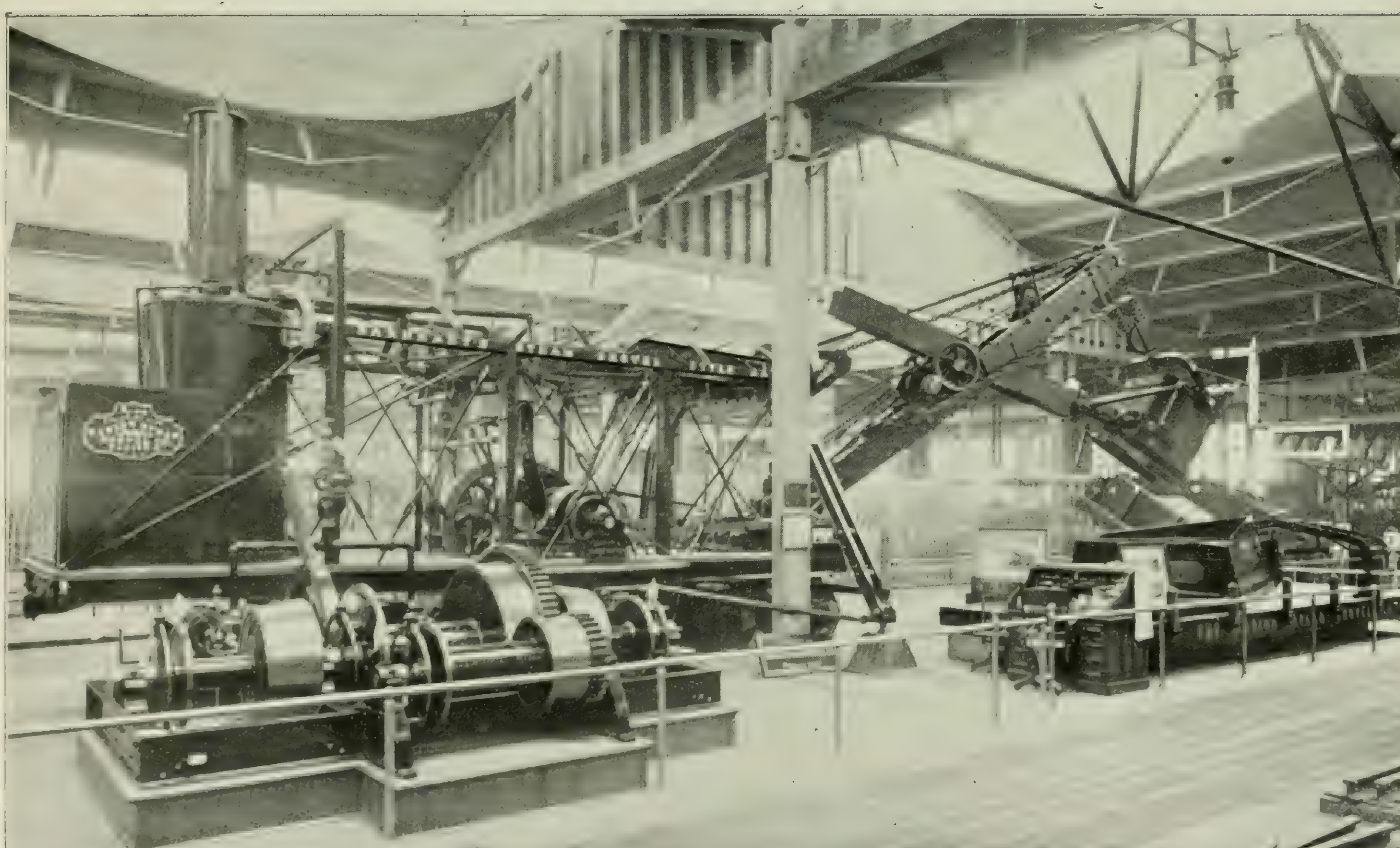
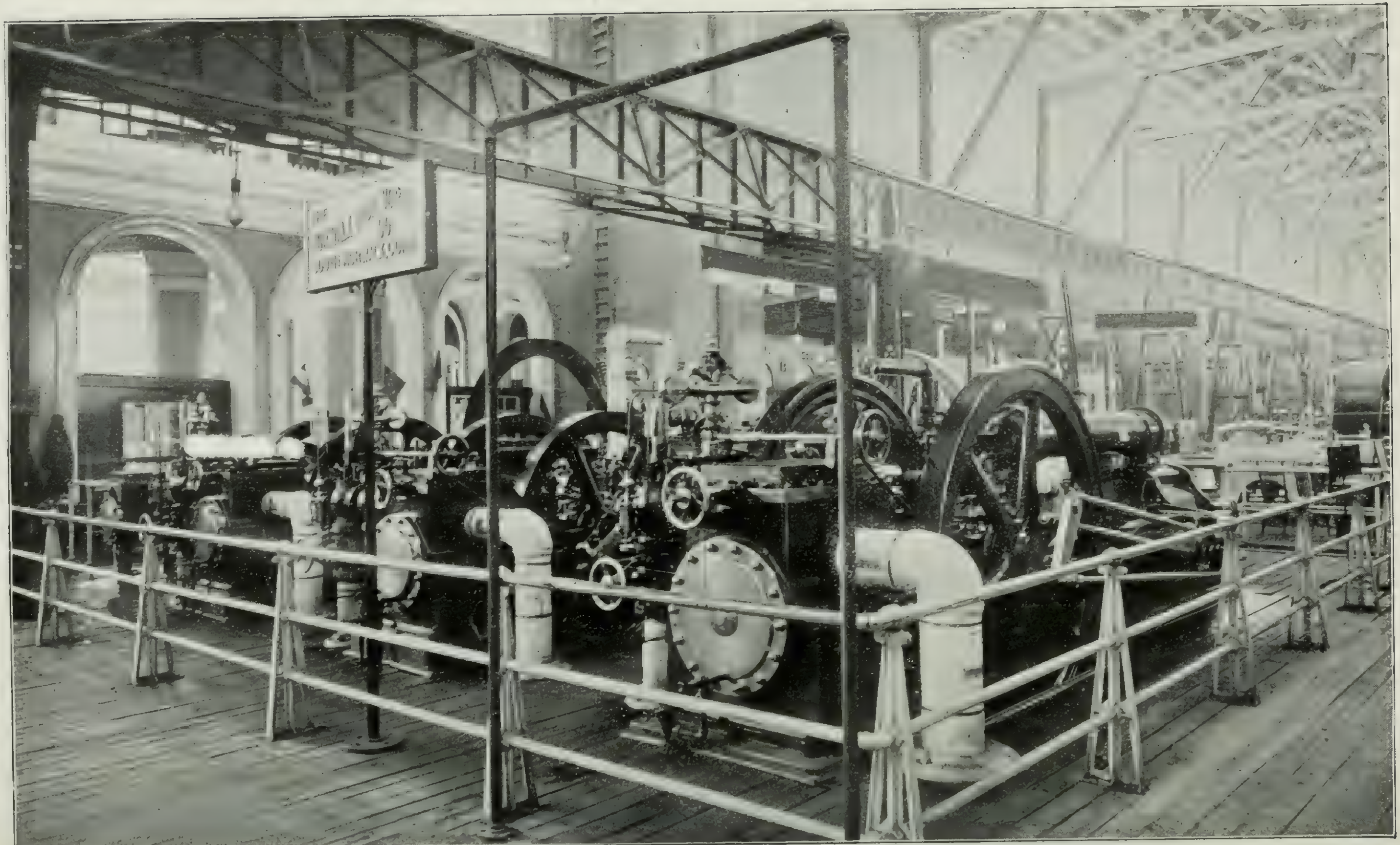


THE HARRISBURG STEAM ROAD ROLLER—HARRISBURG FOUNDRY & MACHINE WORKS. HARRISBURG, PA.

Actively employed for 18 months in making the road-ways of the Fair grounds.



TRANSPORTATION BUILDING—EXHIBIT OF THE MARION STEAM SHOVEL CO., MARION, OHIO—STEAM SHOVELS, DREDGES, EXCAVATORS, ETC.



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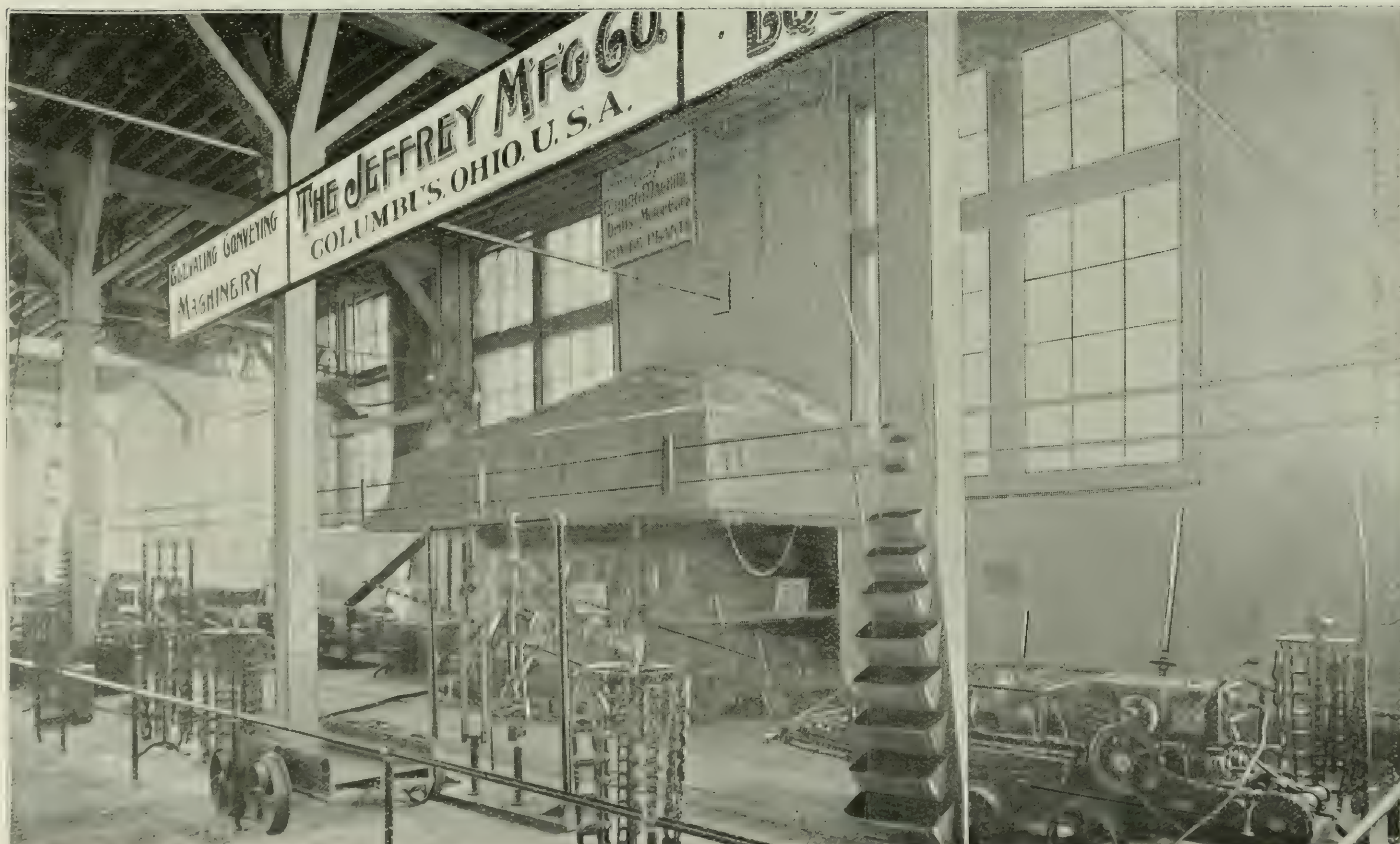
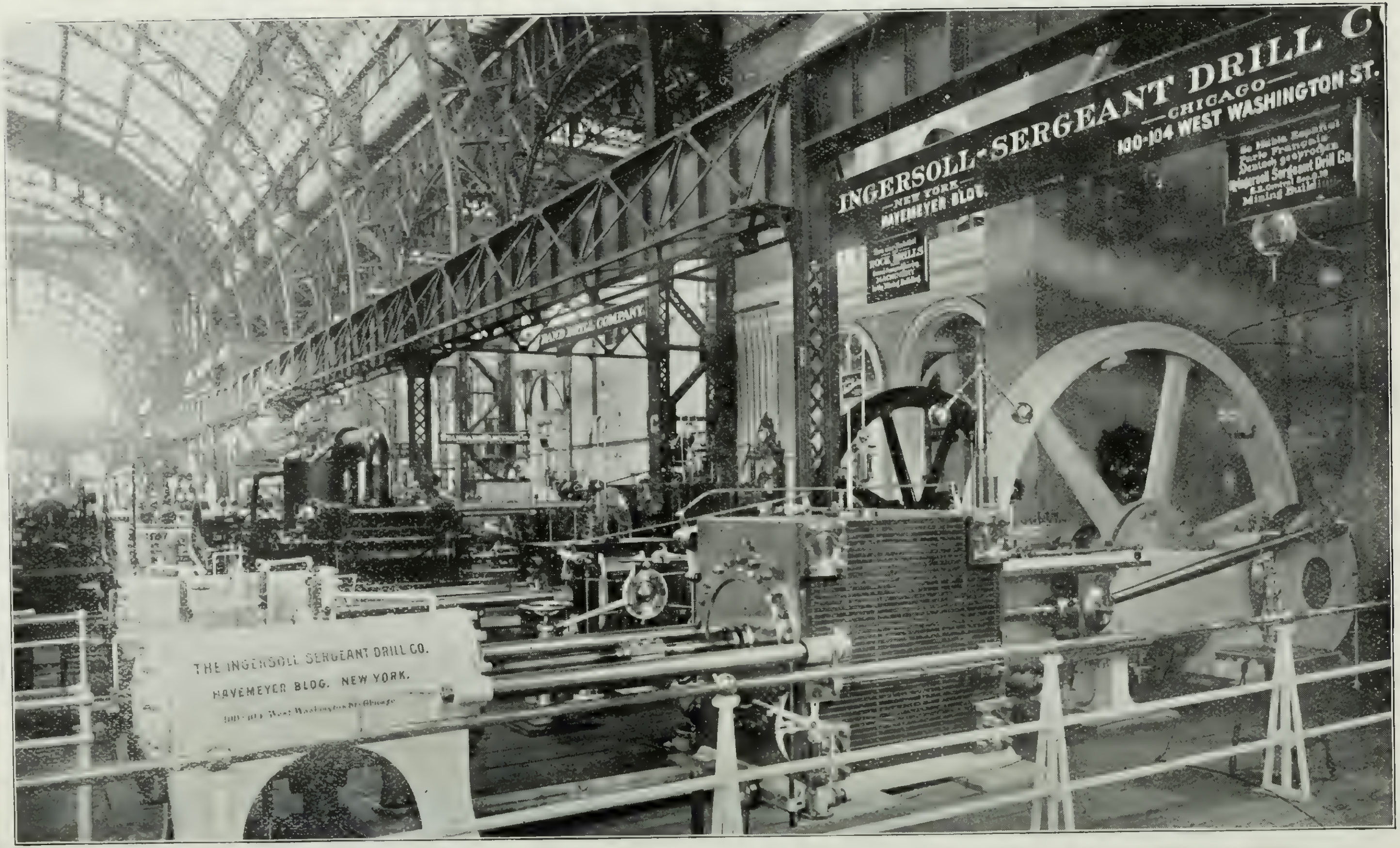
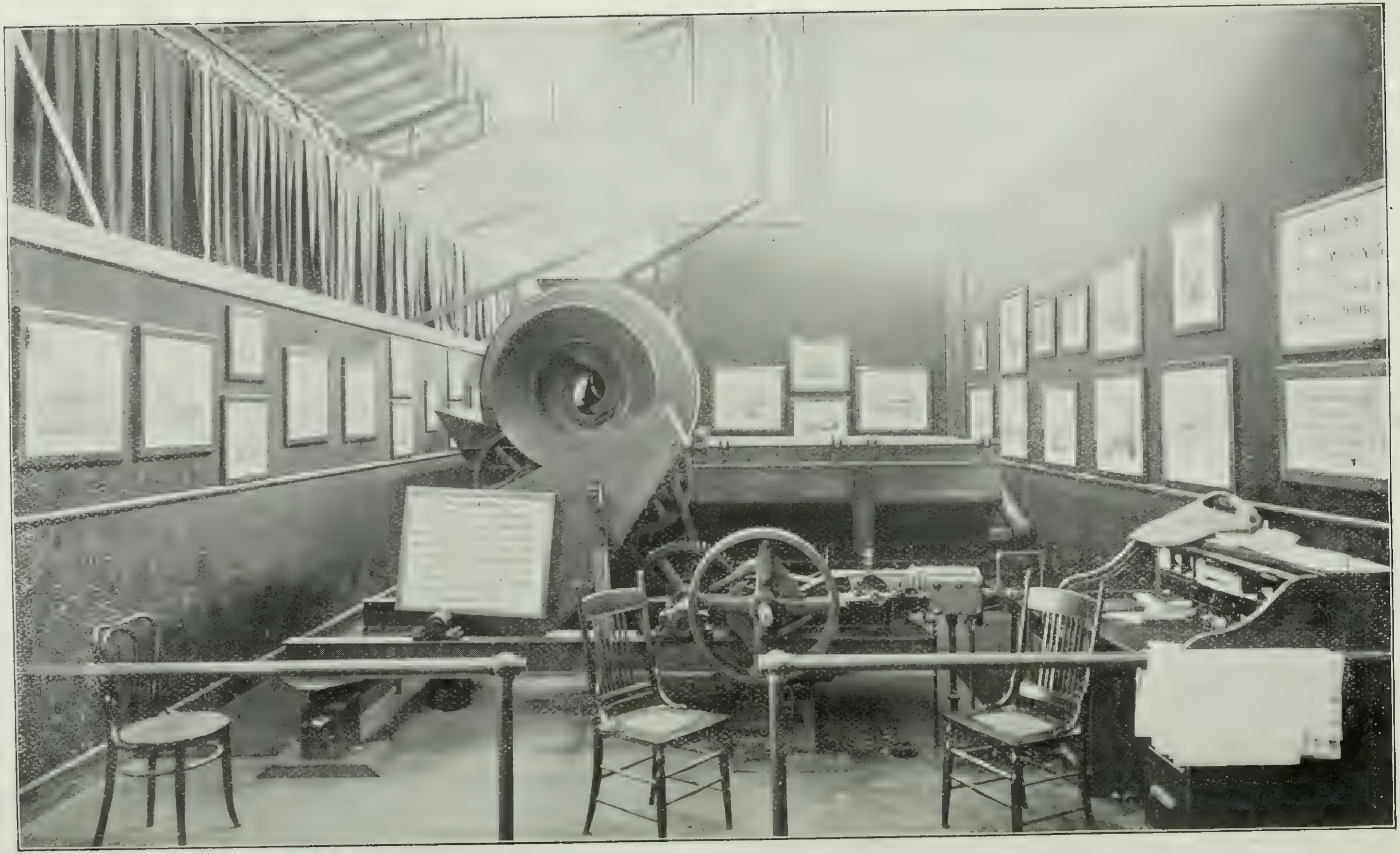


MINES AND MINING BUILDING.—EXHIBIT OF THE JEFFREY M'F'G CO., COLUMBUS, OHIO.—CONVEYING MACHINERY, ELECTRIC COAL CUTTERS, AND MINING MACHINERY.

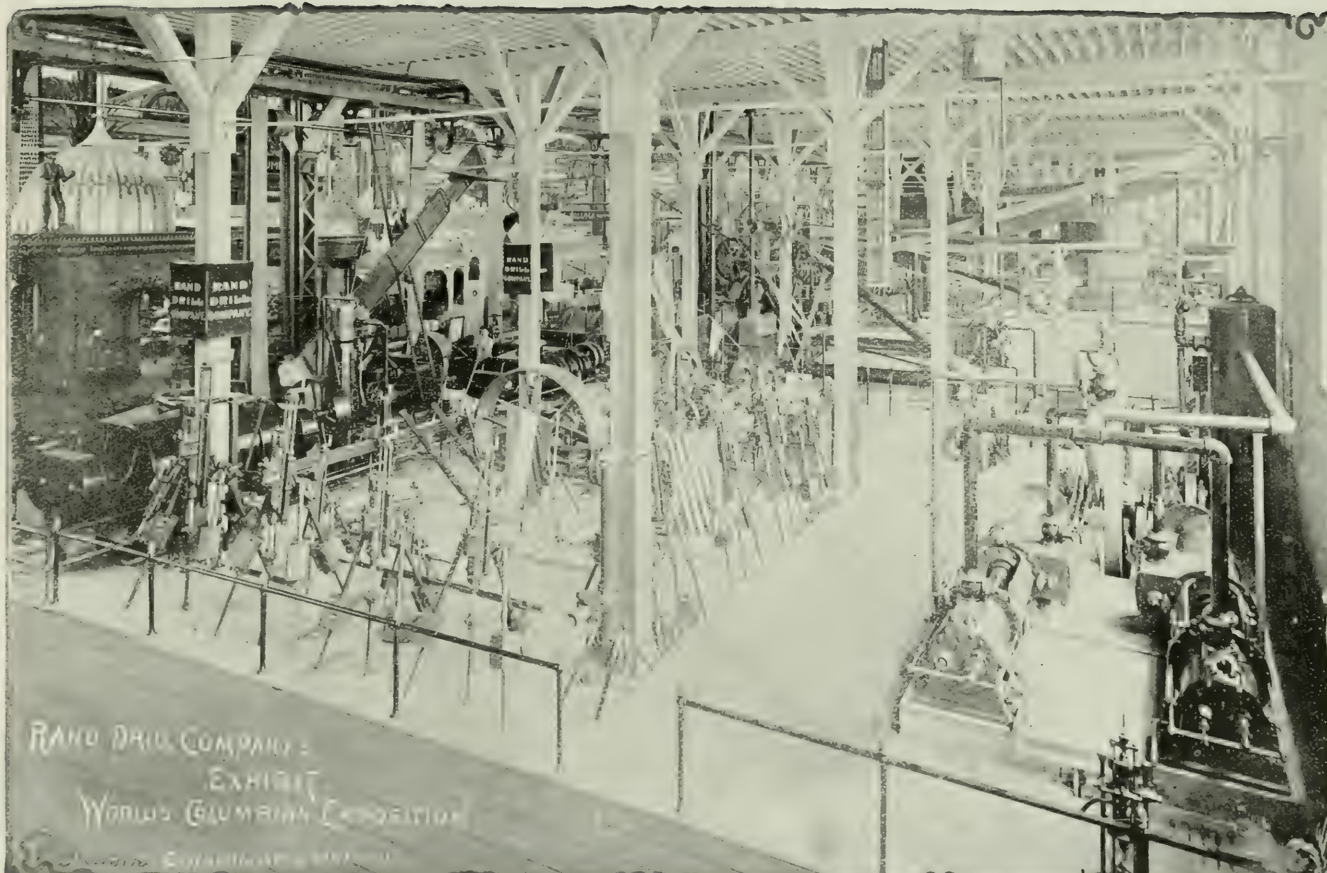


MINES AND MINING BUILDING—EXHIBIT OF THE INGERSOLL-SERGEANT DRILL CO.—AIR COMPRESSORS, ROCK DRILLS AND GENERAL MINING MACHINERY.

MINES AND MINING BUILDING—EXHIBIT OF THE WEBSTER, CAMP & LANE MACHINE CO.—CORLISS ENGINES, HOISTING ENGINES, AND GENERAL MINING MACHINERY.



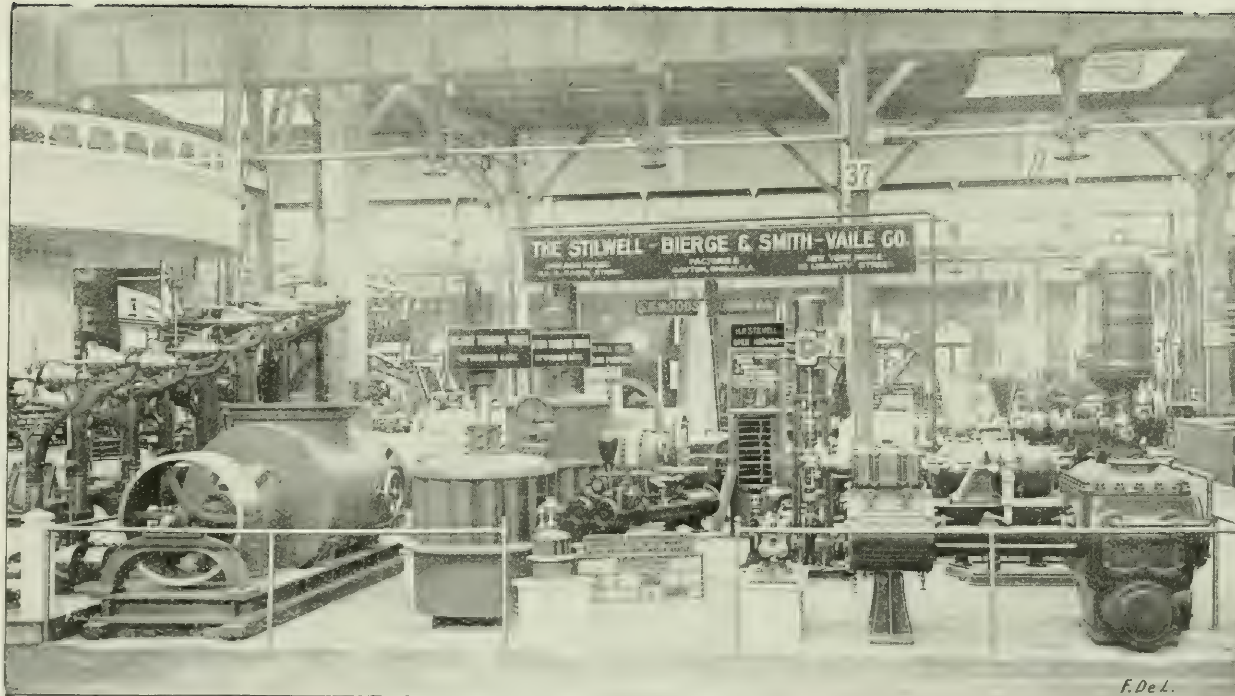
MINES AND MINING BUILDING—EXHIBIT OF THE BUCYRUS STEAM SHOVEL AND DREDGE CO., SOUTH MILWAUKEE, WIS.—PLACER AMALGAMATORS.



MINES AND MINING BUILDING—EXHIBIT OF THE RAND DRILL CO., NEW YORK—AIR COMPRESSORS, ROCK DRILLS AND GENERAL MINING MACHINERY.

MINES AND MINING BUILDING—EXHIBIT OF WILLIAM JESSOP & SONS, LTD., SHEFFIELD AND NEW YORK—STEEL MANUFACTURERS.

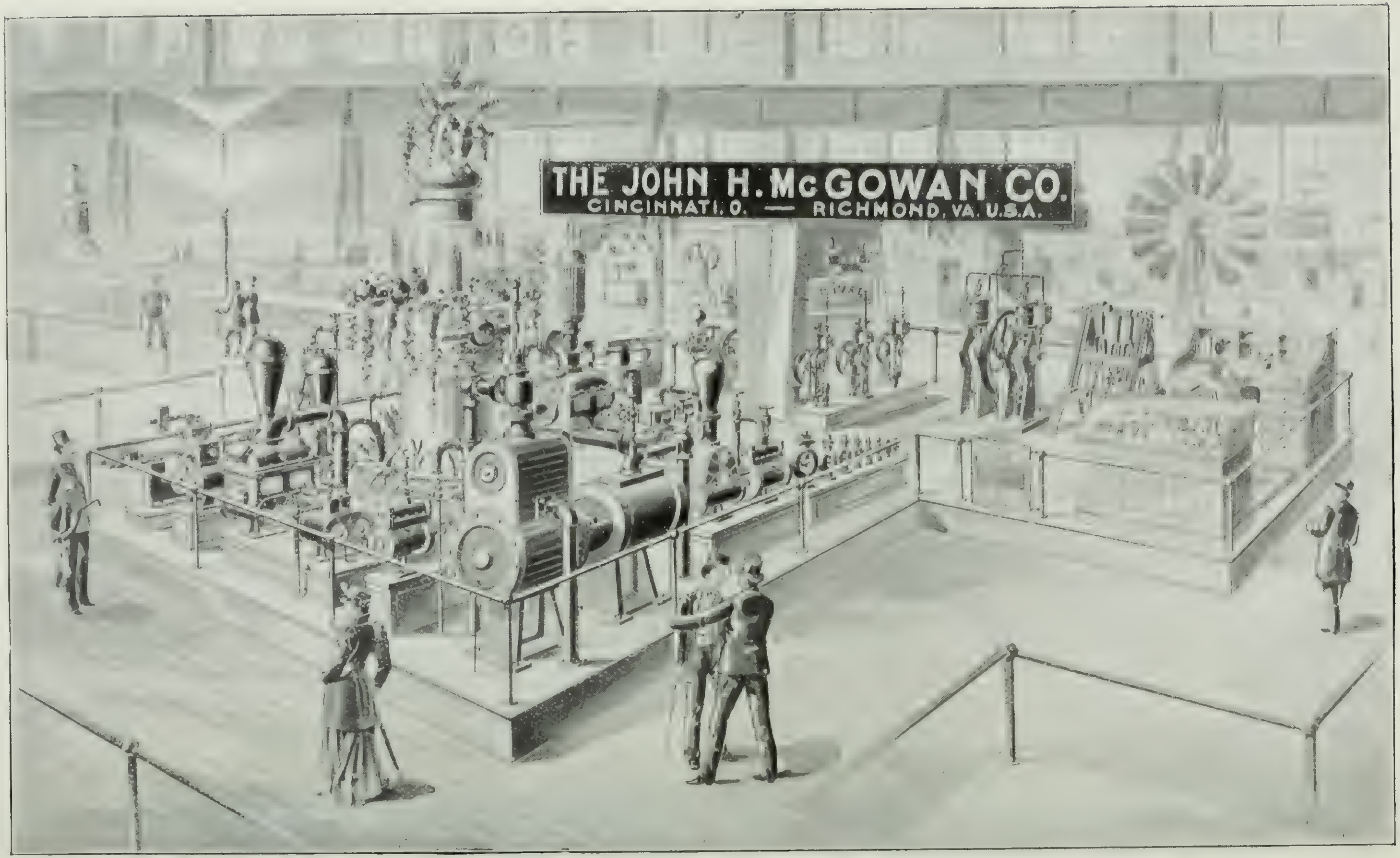
(This entire exhibit was presented by the firm to the Chicago Columbian Museum.)



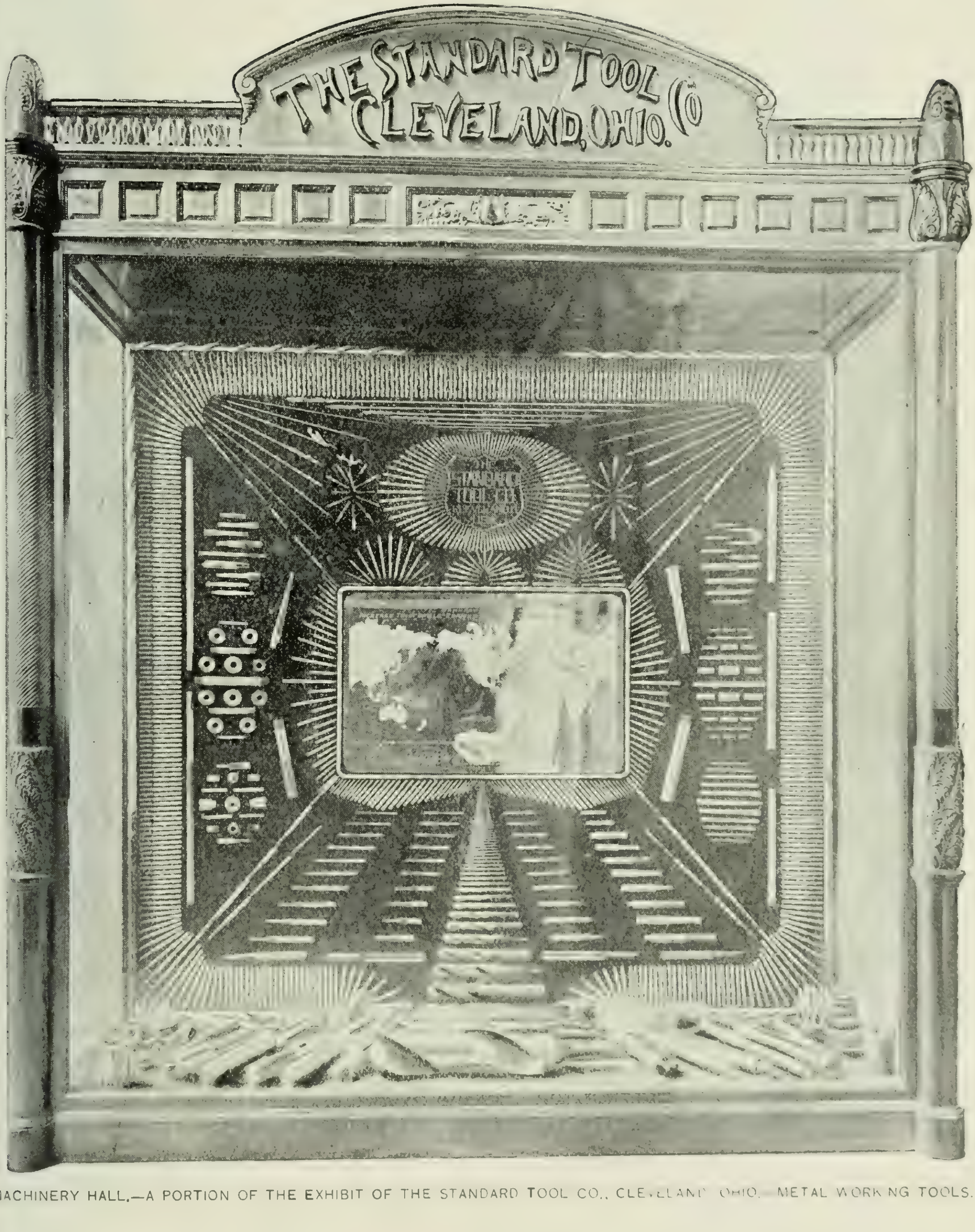
MACHINERY HALL. -EXHIBIT OF THE STILLWELL-BIERCE AND SMITH-VAILE CO, DAYTON, OHIO.- STEAM PUMPS, TURBINE WATER WHEELS, FEED-WATER HEATERS ETC.

MACHINERY HALL.—THE HENRY R. WORTHINGTON EXHIBIT OF PUMPING MACHINERY.

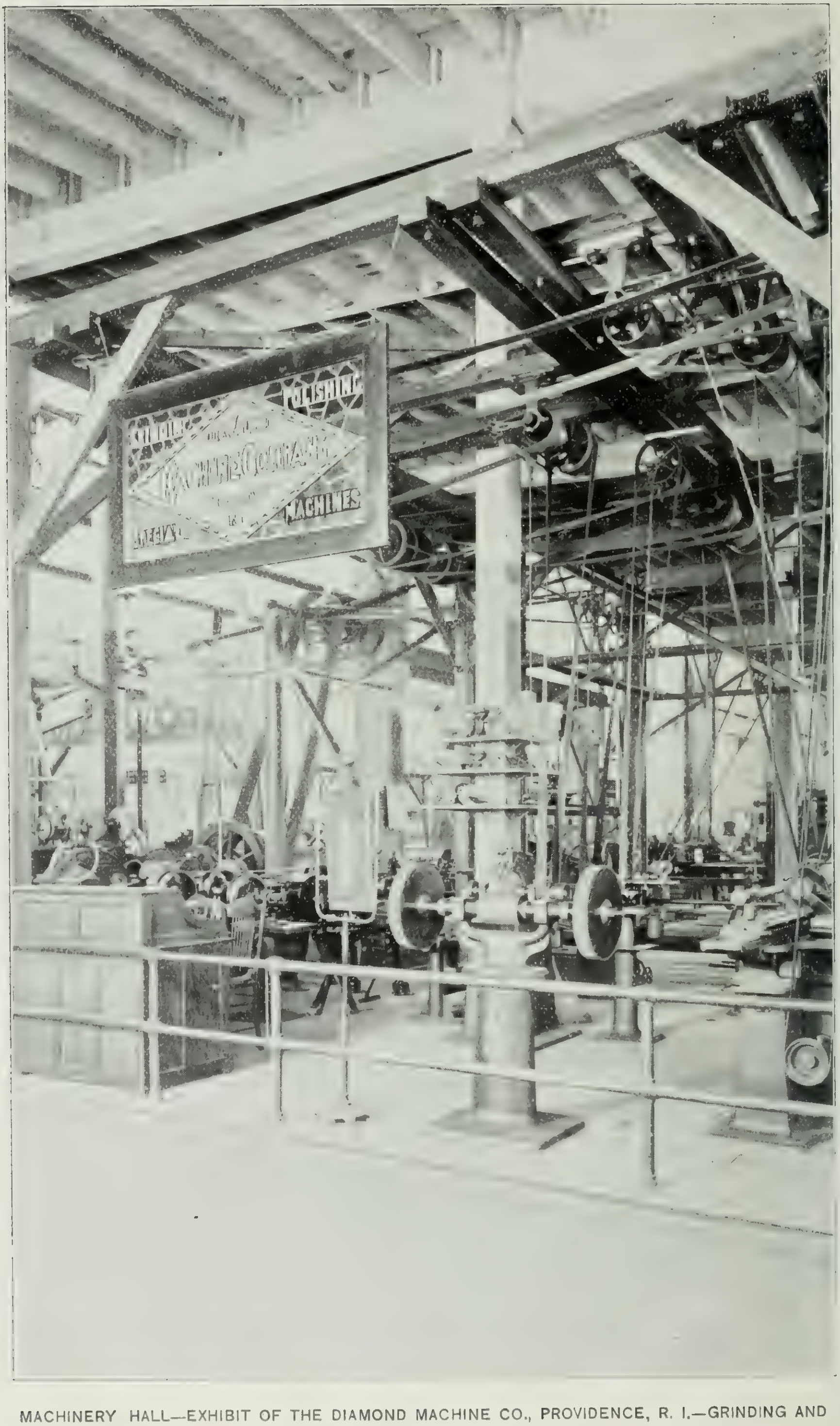
MACHINERY HALL. EXHIBIT OF THE STILES & PARKER PRESS CO., BROOKLYN, N. Y.—DROP PRESSES, DIES, ETC.



MACHINERY HALL.—EXHIBIT OF THE JOHN H. McGOWAN CO., CINCINNATI, OHIO.—PUMP MANUFACTURERS.



MACHINERY HALL.—A PORTION OF THE EXHIBIT OF THE STANDARD TOOL CO., CLEVELAND, OHIO. METAL WORKING TOOLS.



MACHINERY HALL—EXHIBIT OF THE DIAMOND MACHINE CO., PROVIDENCE, R. I.—GRINDING AND POLISHING MACHINERY.

MACHINERY HALL—EXHIBIT OF THE CLEVELAND TWIST DRILL CO., CLEVELAND, OHIO—METAL-WORKING TOOLS.

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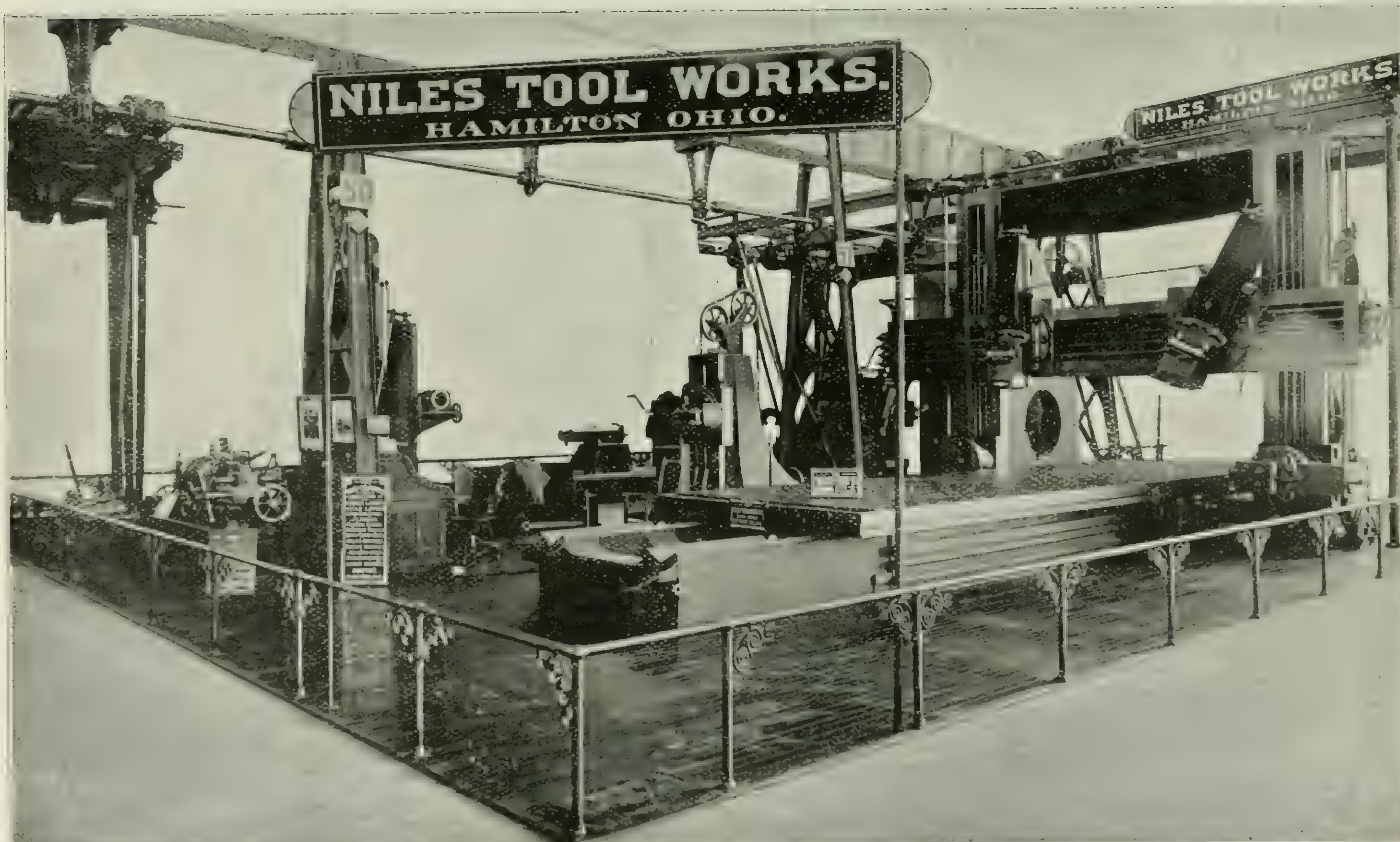
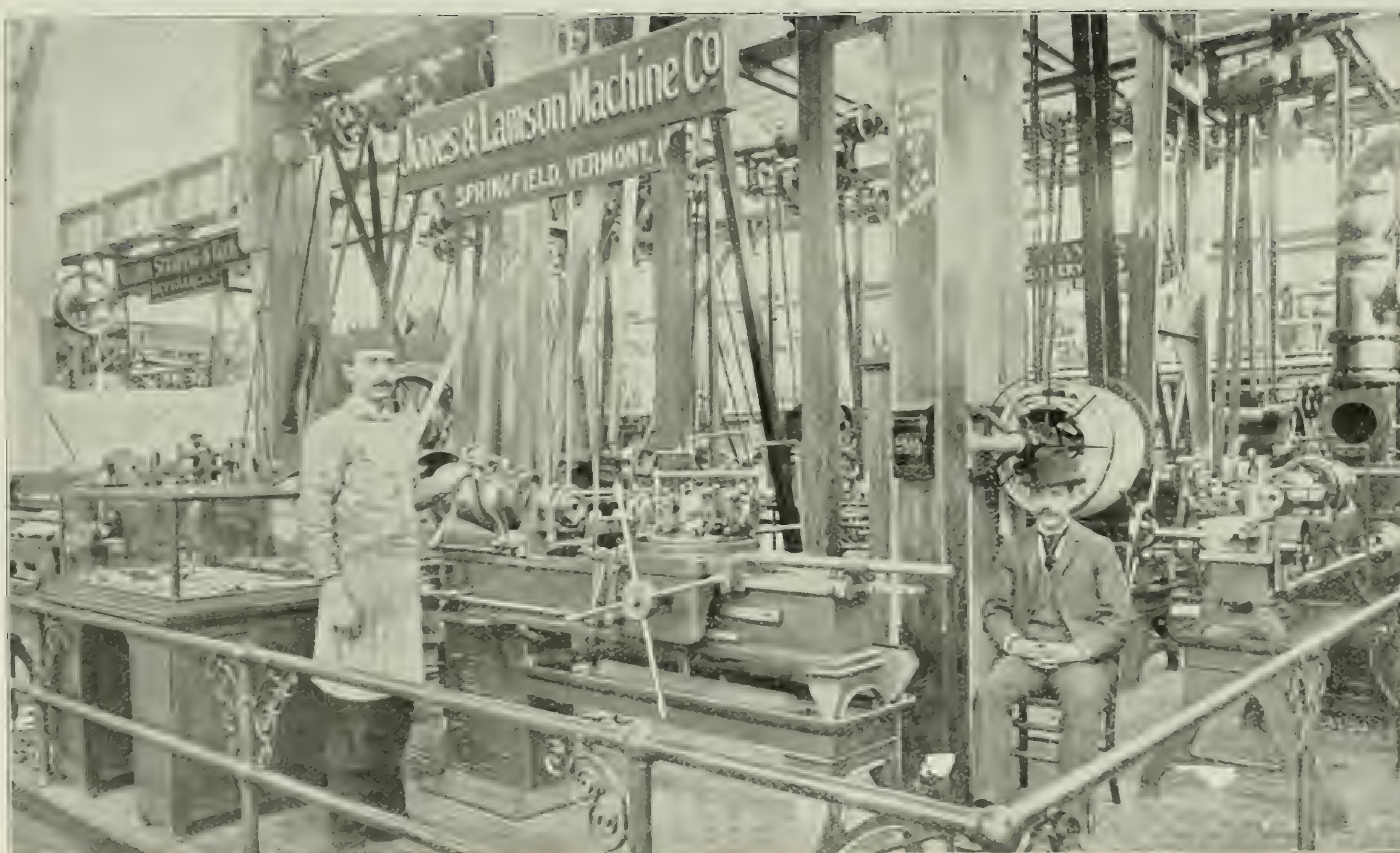
MACHINERY HALL.—EXHIBIT OF THE LAIDLAW-DUNN-GORDON CO. CINCINNATI, OHIO.—PUMPS AND PUMPING MACHINERY.

MACHINERY HALL.—EXHIBIT OF THE BILLINGS & SPENCER CO., HARTFORD, CONN.—DROP FORGINGS.



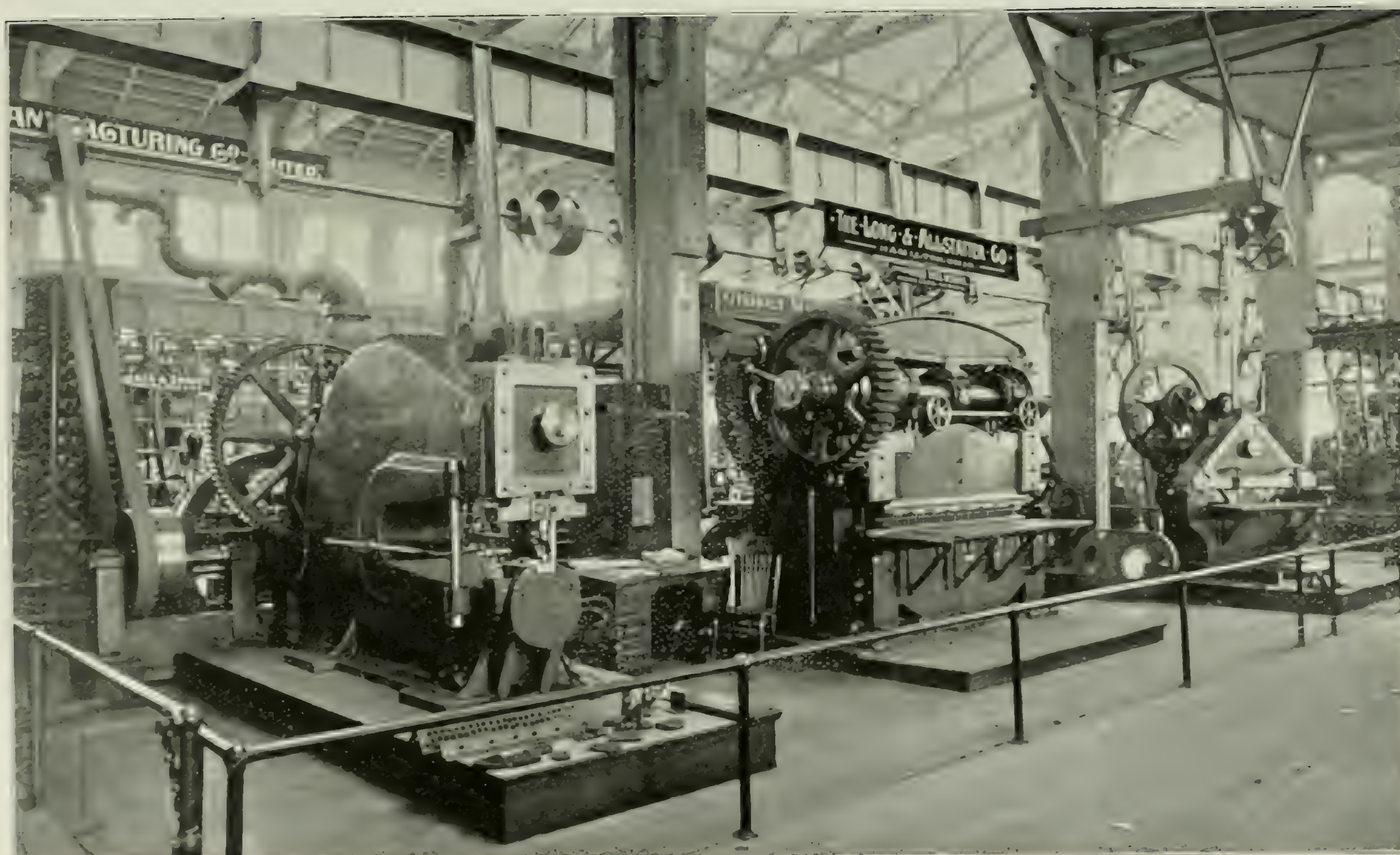
MACHINERY HALL. EXHIBIT OF THE NILES TOOL WORKS, HAMILTON, OHIO.—MACHINE TOOLS.

MACHINERY HALL.—EXHIBIT OF THE SHERWOOD MFG. CO., BUFFALO, N. Y.—ENGINE-ROOM SPECIALTIES.

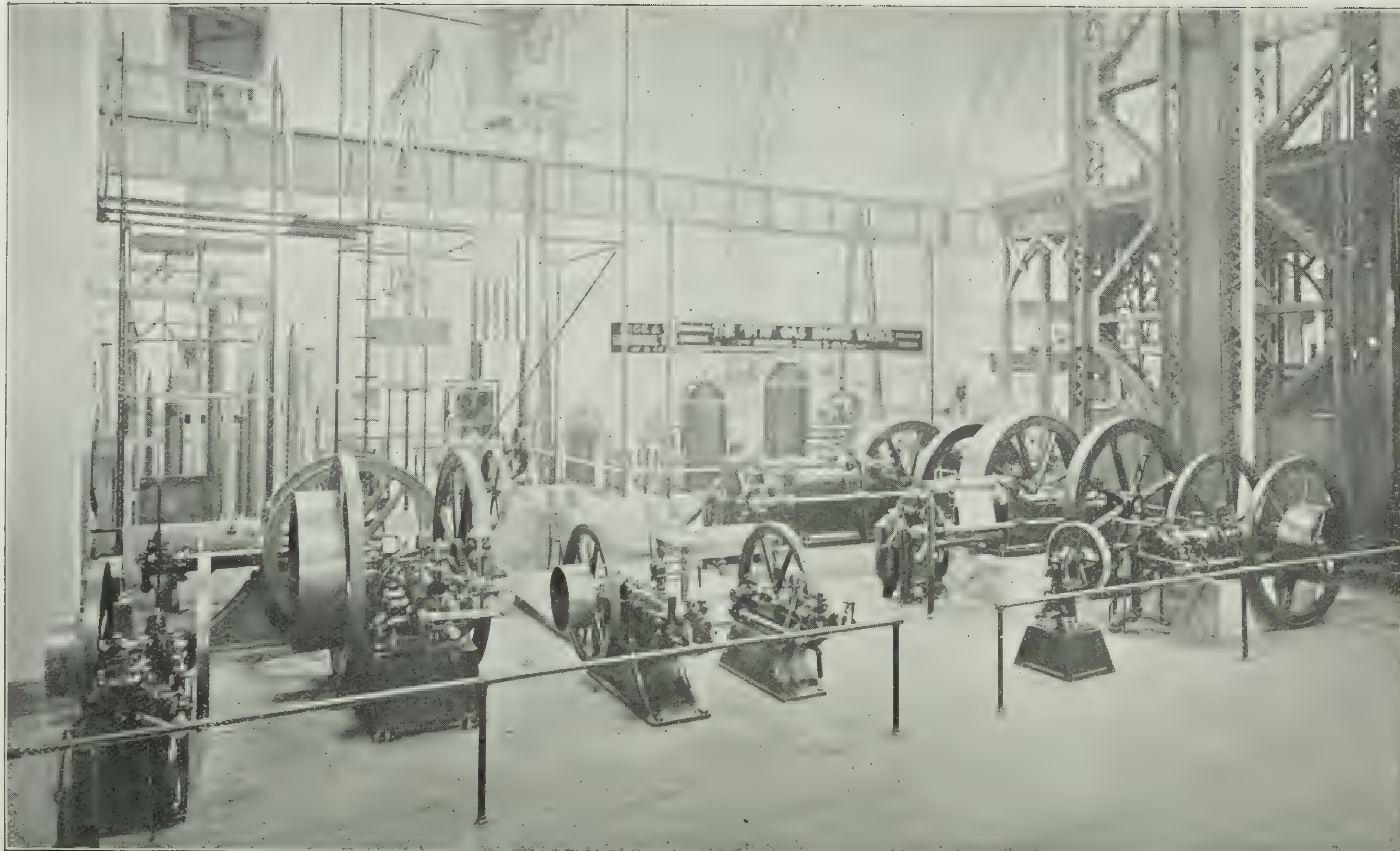


MACHINERY HALL.—EXHIBIT OF THE JONES & LAMSON MACHINE CO., SPRINGFIELD, VT.—MACHINE TOOLS.

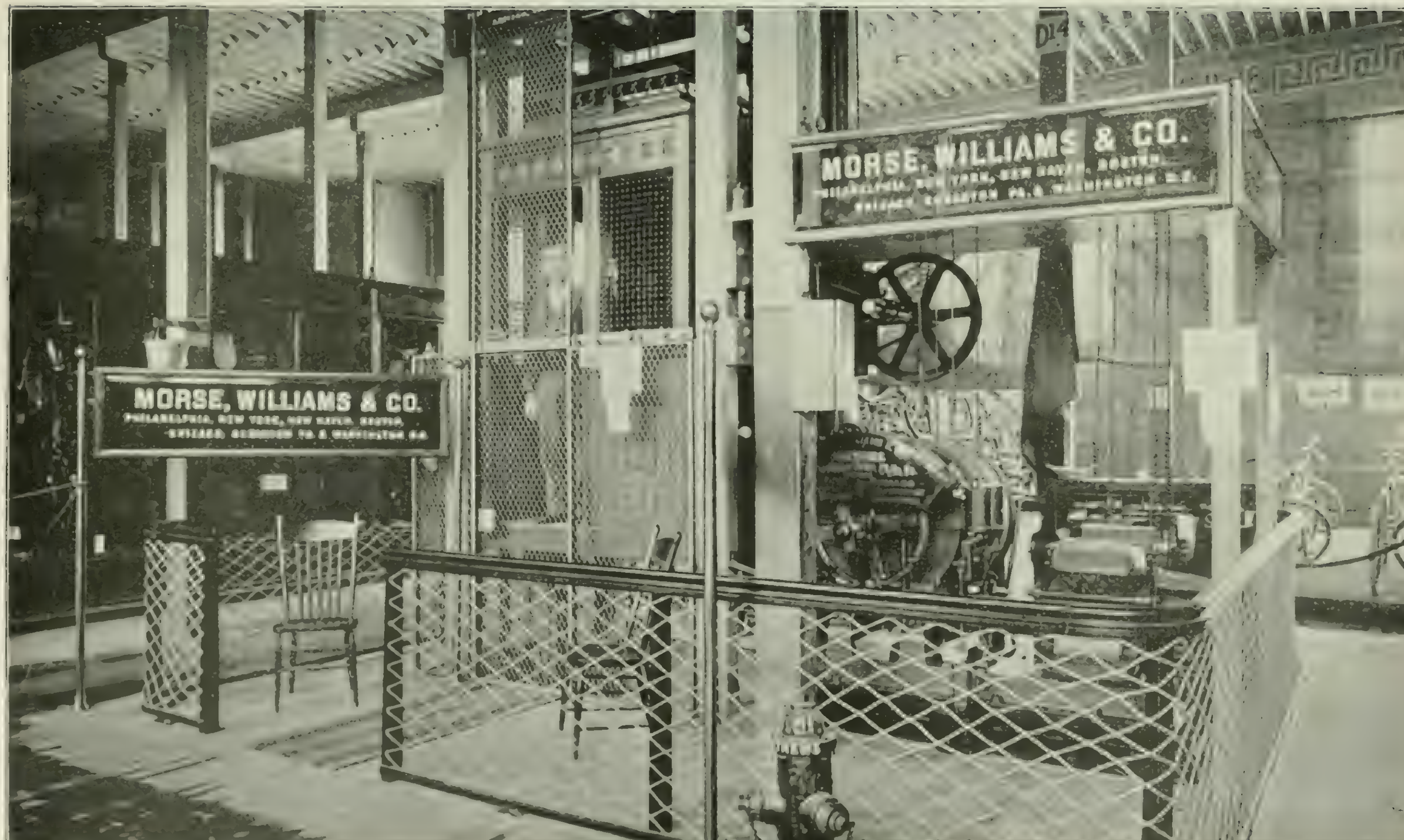
MACHINERY HALL.—EXHIBIT OF THE E. W. BLISS CO., BROOKLYN, N. Y.—DROP PRESSES, DIES, ETC.



MACHINERY HALL.—EXHIBIT OF THE LONG & ALLSTATTER CO., HAMILTON, OHIO.—MACHINE TOOLS.



MACHINERY HALL.—EXHIBIT OF THE OTTO GAS ENGINE WORKS, PHILADELPHIA, PA.



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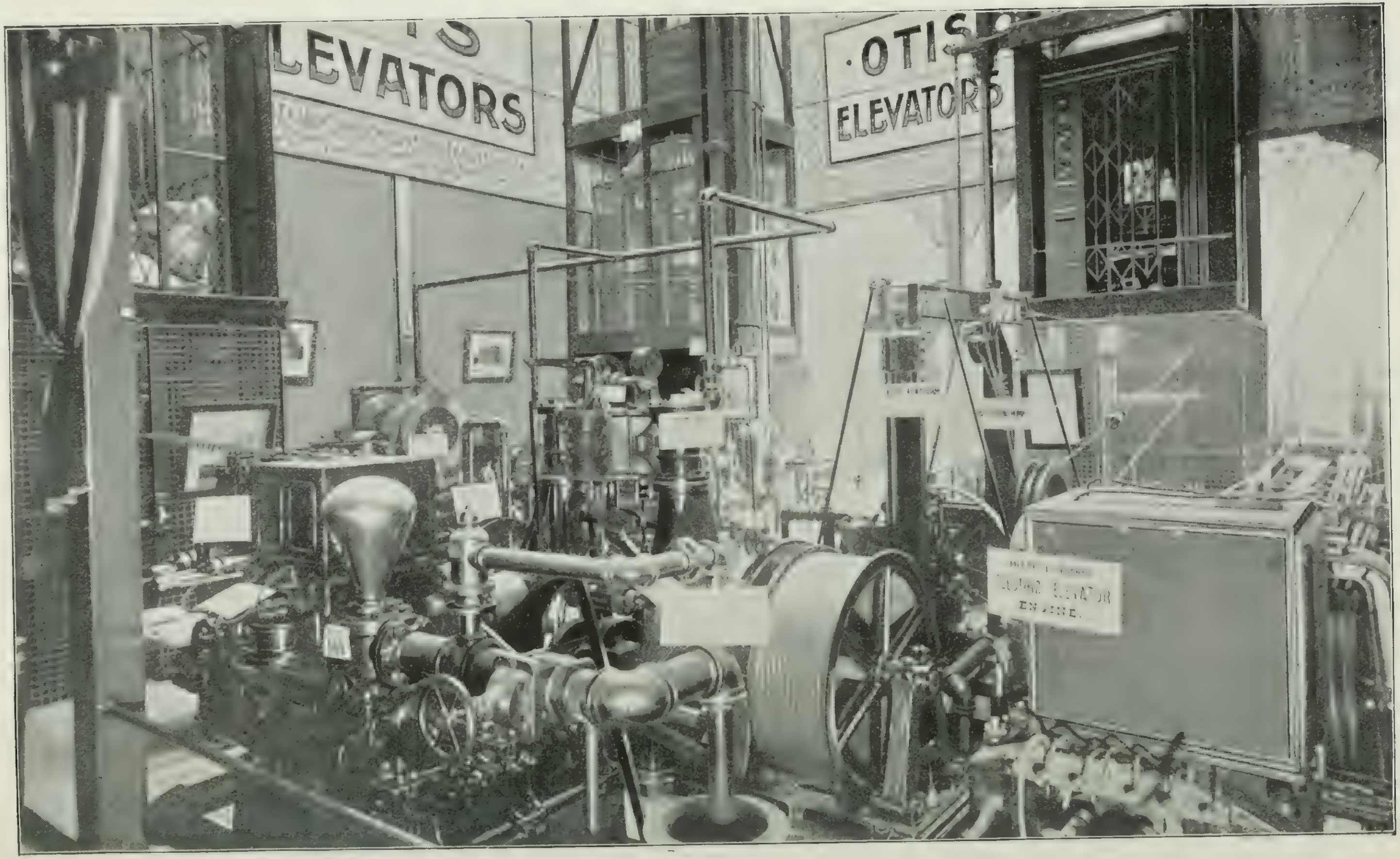
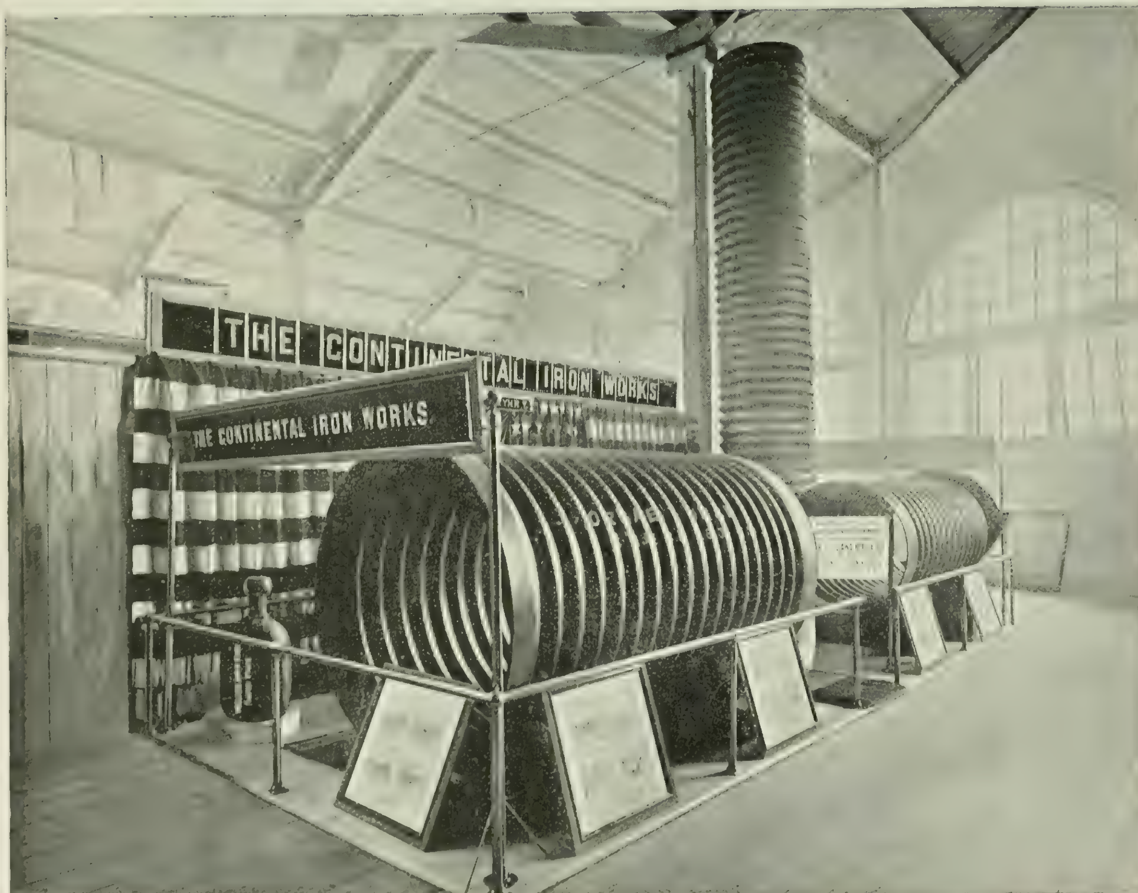
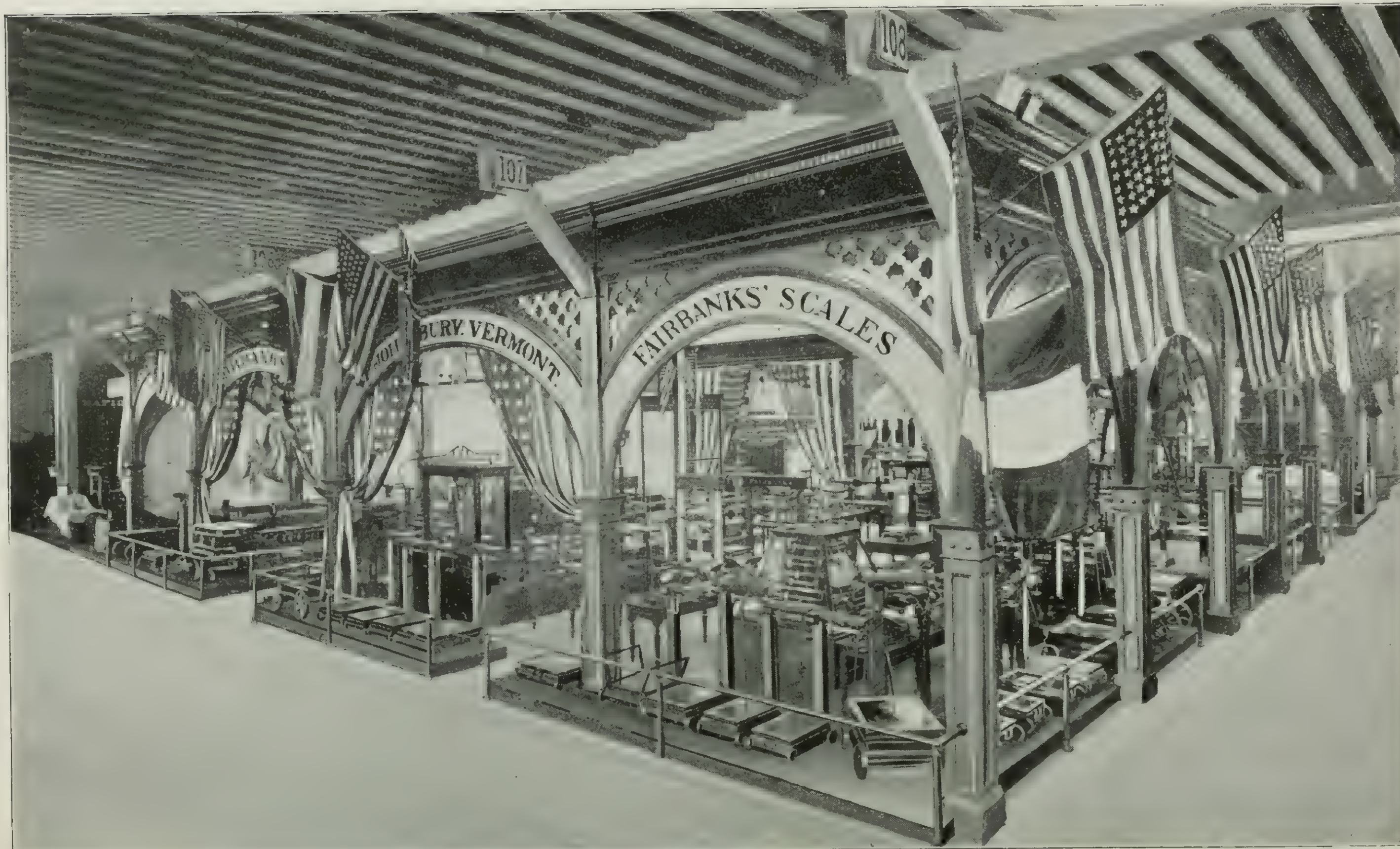


TRANSPORTATION BUILDING—EXHIBIT OF OTIS BROS. & CO., NEW YORK.—ELECTRIC, HYDRAULIC AND STEAM ELEVATORS.



TRANSPORTATION BUILDING—EXHIBIT OF THE CONTINENTAL IRON WORKS, BROOKLYN, N. Y.—CORRUGATED MARINE BOILER FURNACES.



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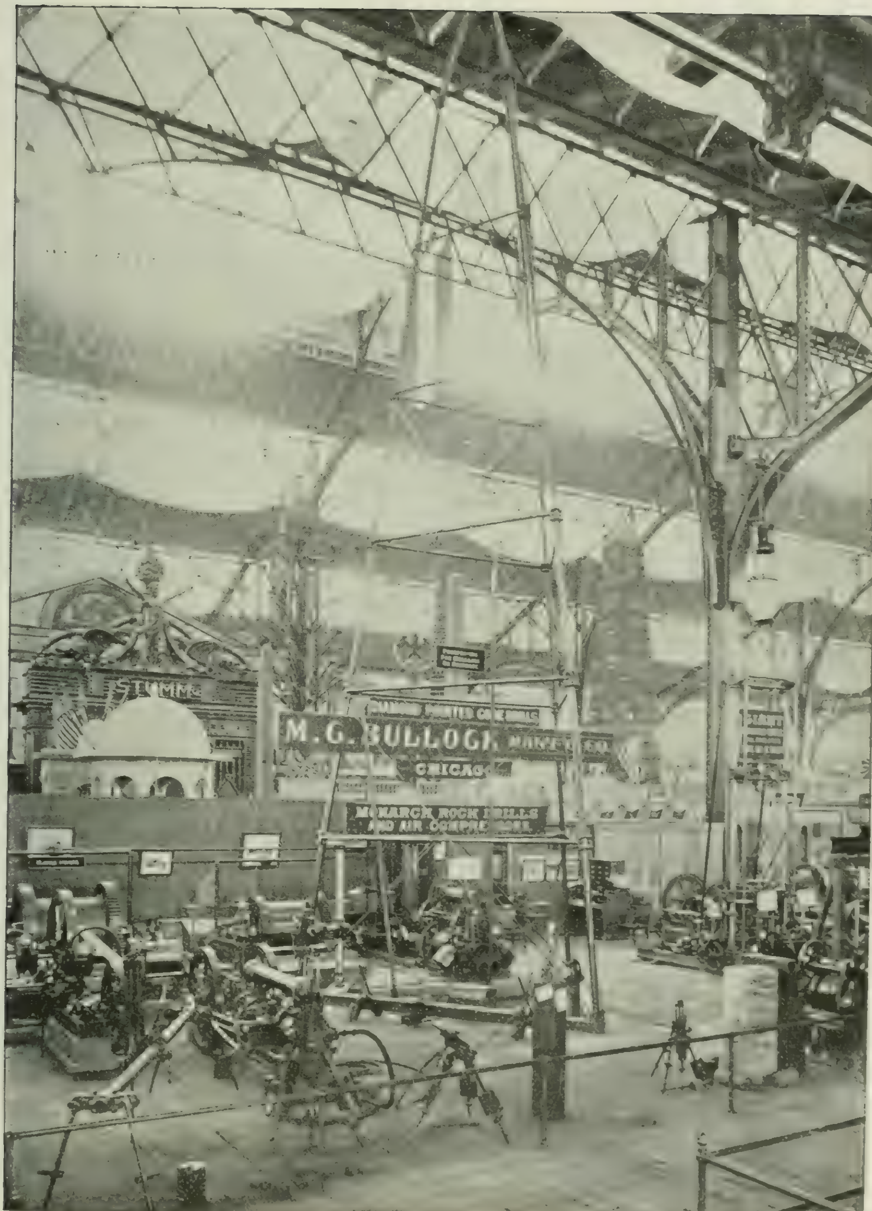
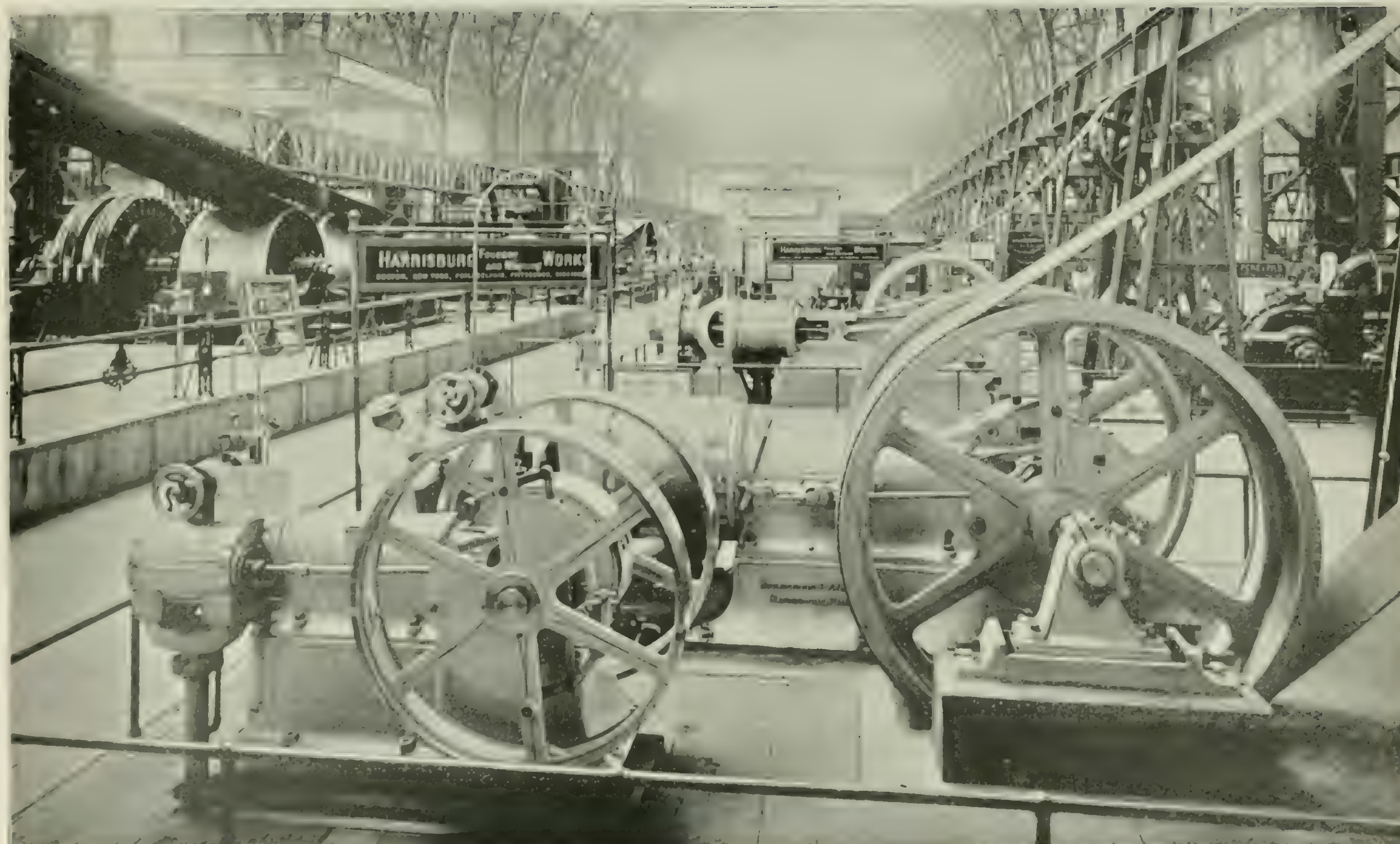


MINES & MINING BUILDING.—EXHIBIT OF THE M. C. BULLOCK M'F'G CO., CHICAGO.—ROCK DRILLS, AIR COMPRESSORS, CORLISS ENGINES AND GENERAL MINING MACHINERY.

MINES & MINING BUILDING—EXHIBIT OF THE CHROME STEEL WORKS, BROOKLYN, N. Y.—SHOES AND DIES FOR STAMP MILLS, AND VAULT STEEL,



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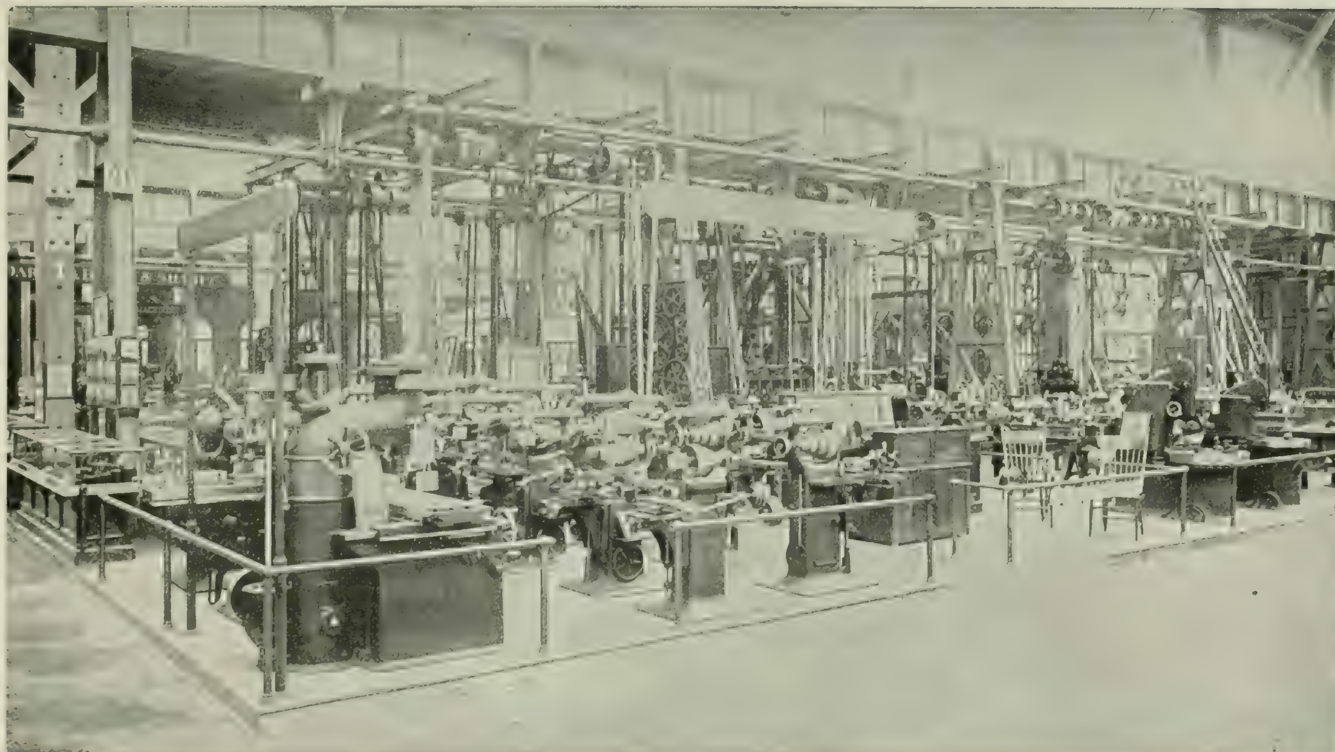
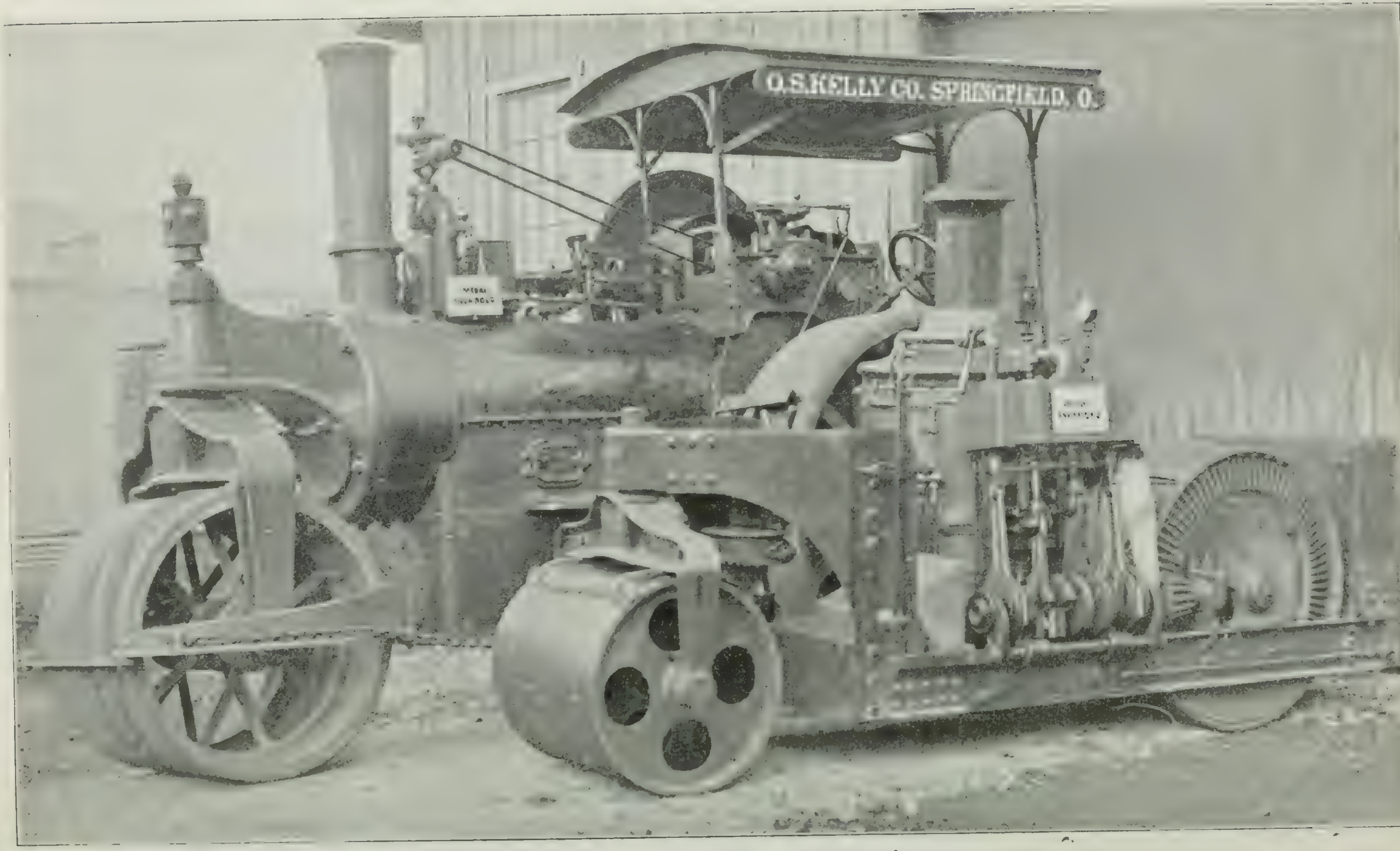


MACHINERY HALL—EXHIBIT OF THE BROWN & SHARPE MFG. CO., PROVIDENCE, R. I.—MACHINE TOOLS.



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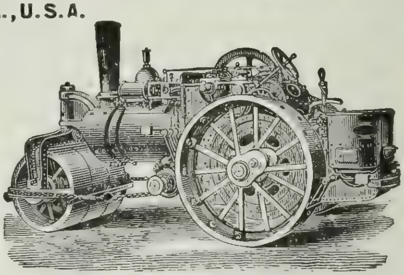

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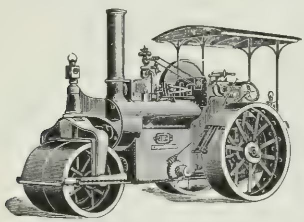

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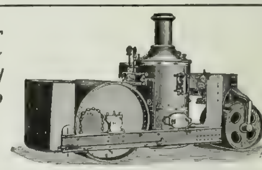

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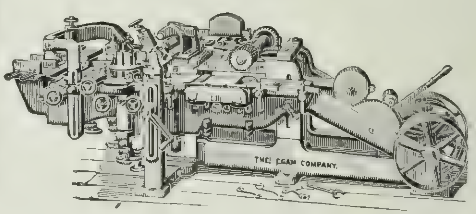

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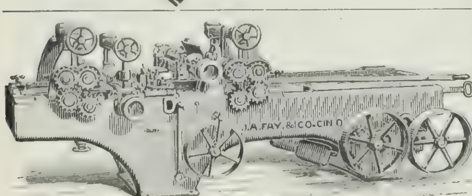

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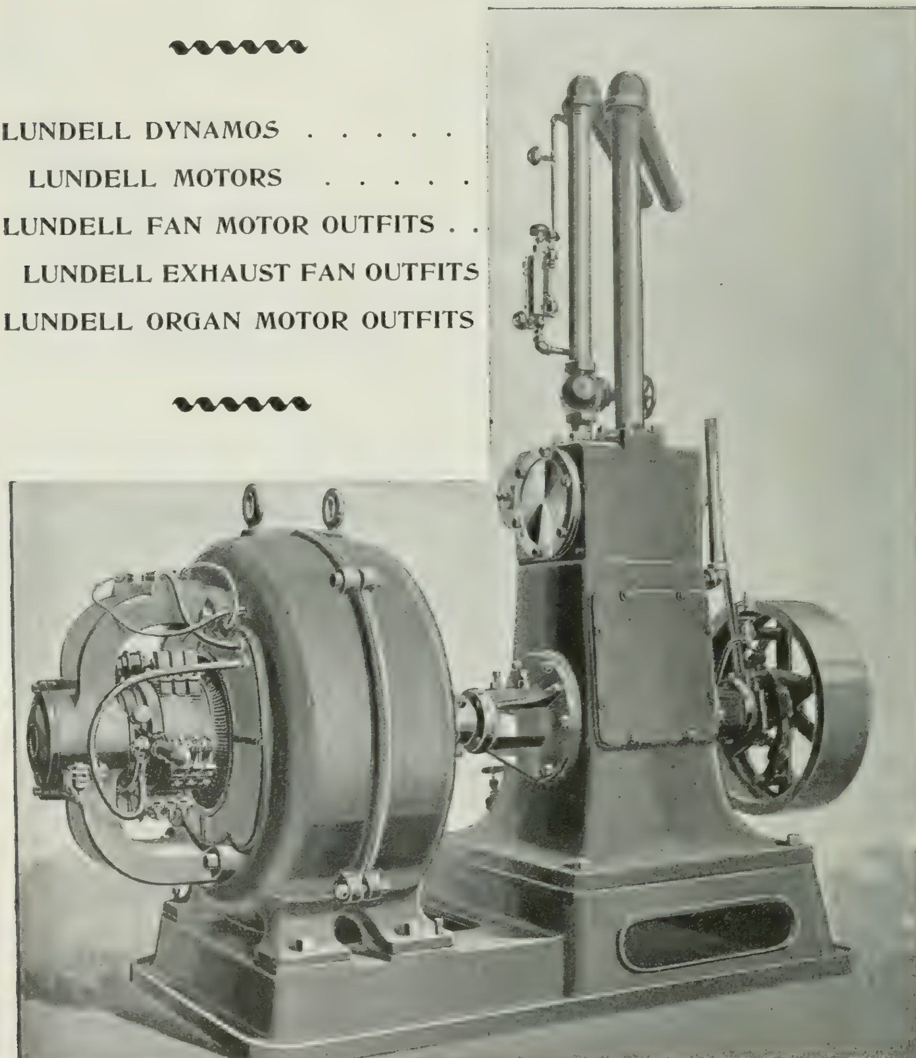

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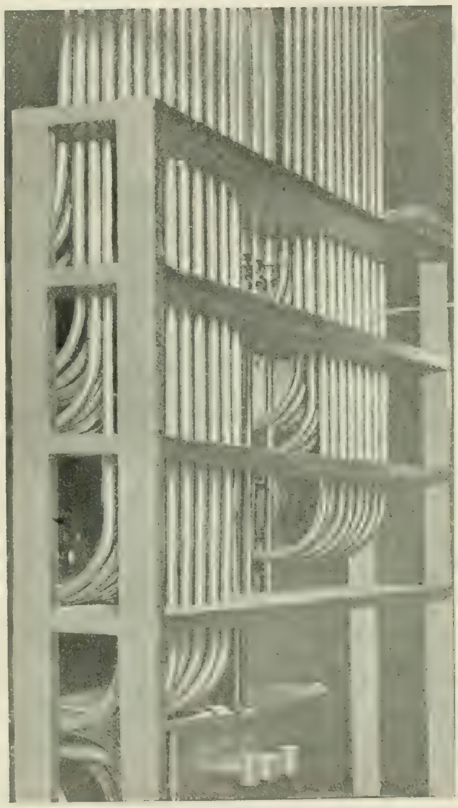

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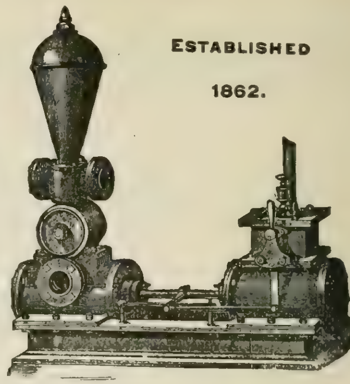

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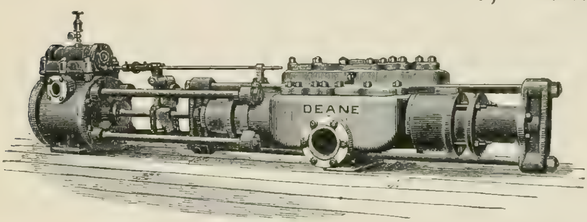

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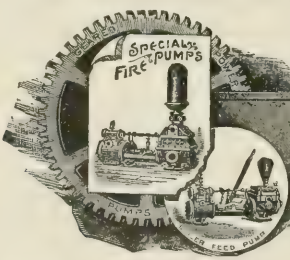

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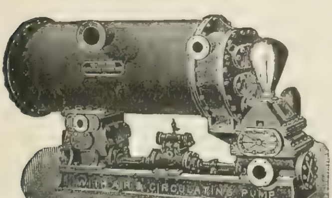

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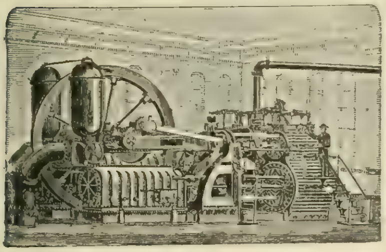

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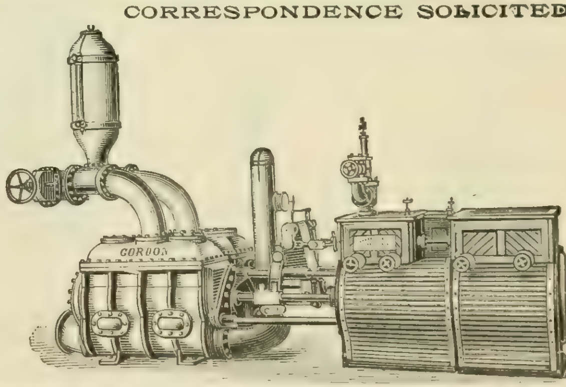

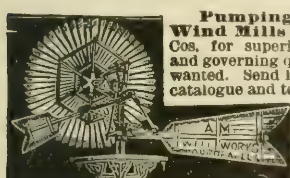

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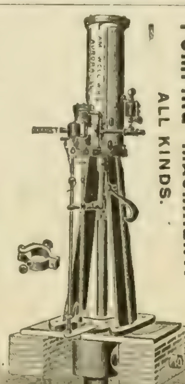

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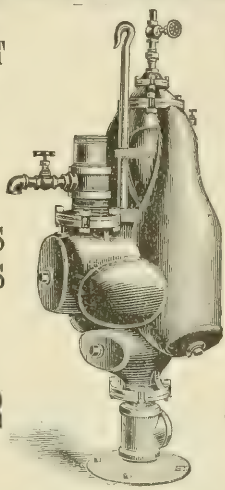

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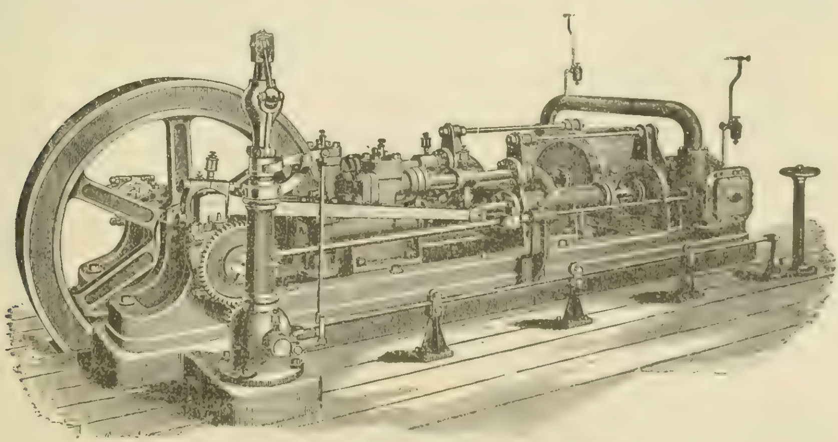


(COMPOUND PUMPING ENGINE, 100 GALLS. PER MINUTE.)

Manufacturers of

Patent Hydraulic Machinery.

Including PUMPS, ACCUMULATORS, MOTORS, BALANCE VALVES, CRANES, FORGING, FLANGING AND STAMPING PRESSES, SHEARING MACHINERY, SINGLE AND MULTIPLE PUNCHING MACHINES, BLOOM AND BILLET SHEARING PLANTS, and

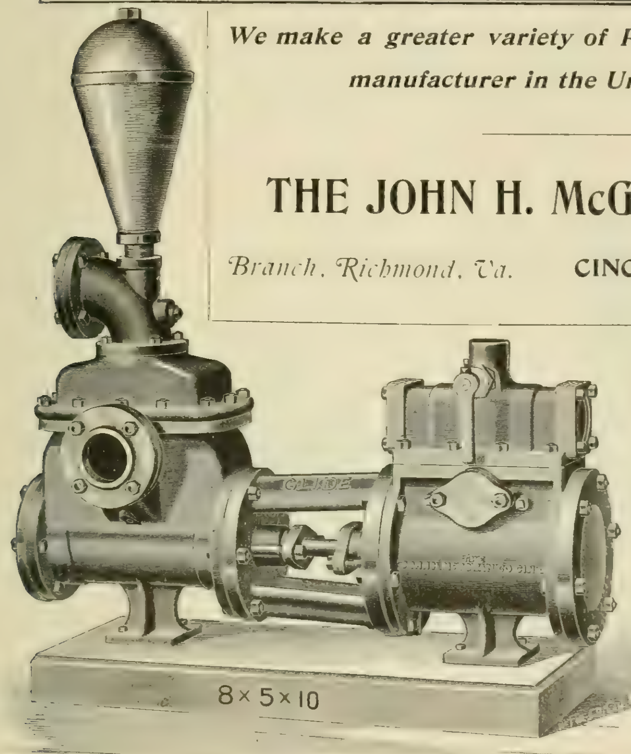
COMPLETE PLANTS FOR BOILER AND BRIDGE BUILDING.

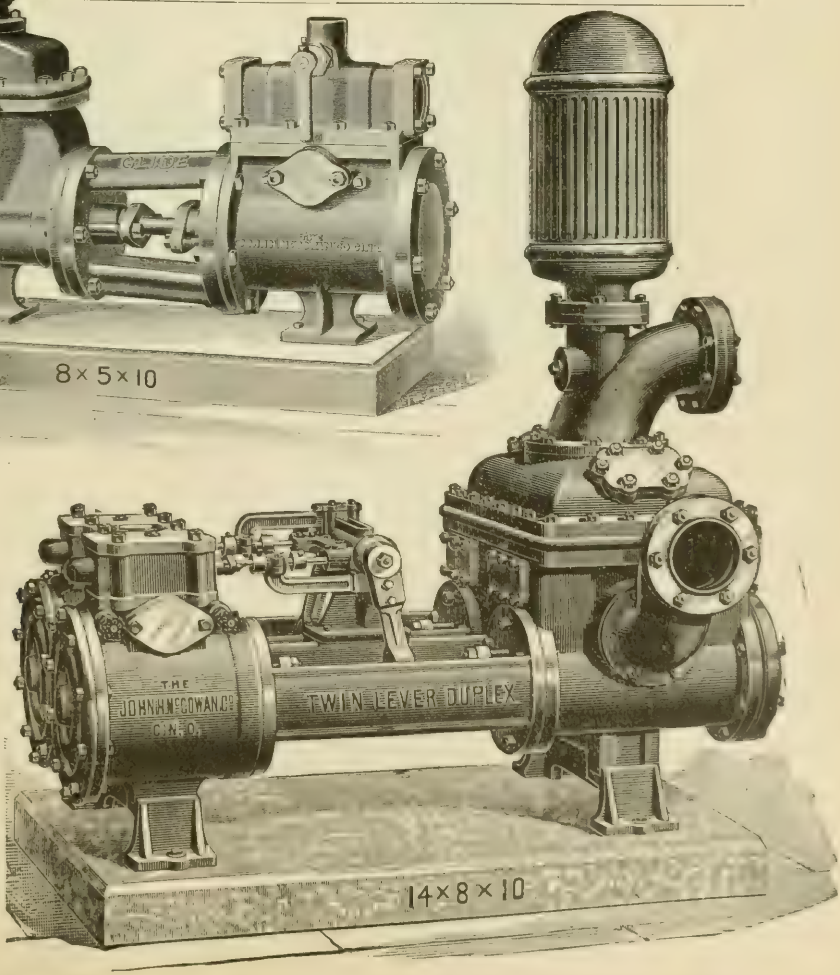
Please mention The Engineering Magazine when you write.

We make a greater variety of Pumps than any other manufacturer in the United States.

THE JOHN H. McGOWAN CO.,

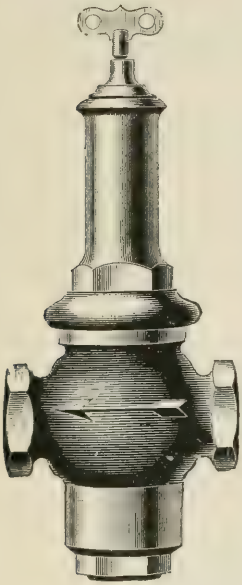
Branch, Richmond, Va. **CINCINNATI, O., U. S. A.**





10 Awards at World's Columbian Exposition

The Mason Regulator Co., = Boston, U. S. A.



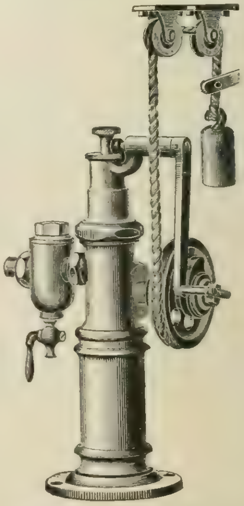
The Mason Reducing Valve.

This valve is designed to reduce and maintain an even steam or air pressure regardless of the initial pressure. It will automatically reduce boiler pressure for steam-heating coils, dry-rooms, paper-making machinery, slashers, dye kettles, and all places where it is desirable to use lower pressure than that of the boiler. The dashpot, which immediately fills with condensation, prevents all chattering or pounding, and requires no attention. No extra lock-up attachment is needed, as the pressure is regulated by a key, which the engineer retains. The sizes, up to and including 2-inch, are made of the best composition, and above that, of cast iron, with composition linings. In the larger sizes, the composition lining is hung up in the valve, leaving a space between the iron and composition for the unequal expansion of the metals, thus there is no possibility of the piston sticking when the valve is heated. The area of the passage from the high to the low pressure side of the valve is equal, when open, to the full area of the pipe, so that a low pressure of the system, almost equal to the initial high pressure, may be carried. This valve will maintain an even steam or air pressure as low as one pound if necessary. We make an iron valve for use with ammonia in ice-making machinery.

Capt. A. B. Reck, formerly of the Royal Danish Engineers, writes : "I am glad to state that the regulators of the Mason Regulator Co., of Boston, are preferred for others in the Danish Navy, by the ship-building firms here, and by the brewers, sugar manufacturers, and for heating apparatus, where steam from high pressure boilers is used for heating. I have sold many of these regulators during the last five years, and I have not had a single case where I have had trouble with them. (Signed) A. B. RECK,

Copenhagen, Denmark."

The Mason Steam Damper Regulator



Is made in accordance with an entirely novel principle in the construction of damper regulators : the steam is admitted from the boiler, through a small strainer, as shown in the cut, under a diaphragm which is attached to an auxiliary valve, which either lets in the steam or excludes it from the piston which works in the cylinder. This piston being forced down by the steam pressure, and carried back by the weight on the damper lever, turns a wheel, from which runs the chain which is connected to the damper. By an ingenious arrangement, the damper is not thrown entirely open by the slightest change of pressure in the boiler, but is gradually opened, as the pressure changes, thereby not allowing sudden and great variations of draft, whereby the coal is wasted.

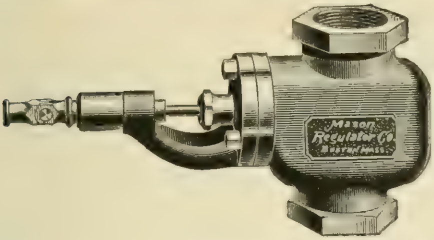
We manufacture only one size. The regulators are made of the best steam metal throughout ; each one is nickel-plated. Weight, 30 pounds. Price, $80.00, including bracket, weight and 25 feet of chain.

Manufactured by Mason Regulator Co., Boston, U. S. A.

Please mention The Engineering Magazine when you write.

The Mason Regulator Co., = Boston, U. S. A.

The Mason Balanced Valve



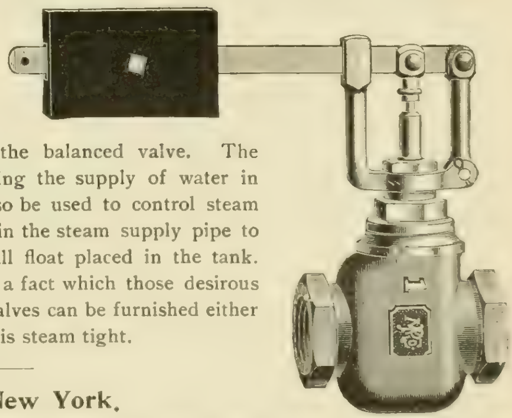
Is a double piston balanced valve, for use in connection with our speed governor, and for which we have found a ready sale in the many cases where such valves are used. The principal advantage of our valve is in the guide for the valve stem, which is cast on the bonnet, thereby keeping the valve stem in a direct line with the stuffing box. For this reason it is impossible for the valve stem to bend, and the packing seldom has to be renewed. The sizes up to two inch are made of the best steam metal ; above that, of cast iron, lined with steam metal. A knuckle-joint tapped for three-eighths rod is on the same stem of each valve. This saves expense in making connections.

De Pauws American Plate Glass Works, New Albany, Ind.

We received the $\frac{1}{2}$ inch reducing steam valve and placed it in the steam pipe leading to the heaters in our office. It works admirably, and we now want one 1-in. Reducer, one $1\frac{1}{2}$-in. Reducer, and one $2\frac{1}{2}$-in. Reducer of the same kind.

Yours truly, W. D. KEYES, Secretary.

The Mason Lever Valve



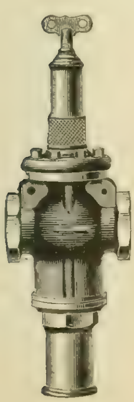
Is made essentially the same as the "Mason Balanced Valve," with the substitution of yoke and lever with weight attached for the bonnet and knuckle joint of the balanced valve. The lever valve will be found useful in controlling the supply of water in tanks by attaching to a ball float. It can also be used to control steam pumps in tank service, by placing the valve in the steam supply pipe to the pump and connecting the lever with a ball float placed in the tank. There is no lost motion in any of the joints, a fact which those desirous of close regulation will appreciate. These valves can be furnished either as piston or seated valves. The latter style is steam tight.

Standard Oil Co., of New York.

Your Regulators are working very well. I have no doubt but they are a good thing on machinery requiring regulation or governors.

Yours truly, F. M. McKINNEY, Supt.

The Mason Pump Pressure Regulator



For fire, tank, elevator, air and water works pumps, or any class of pumping machinery where it is necessary to maintain a constant pressure. The regulator may be instantly adjusted to any pressure desired by simply turning the key as shown in the cut.

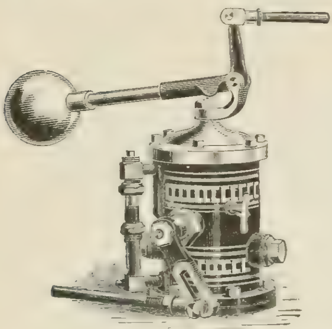
The especial feature of this regulator is that the pressure chamber into which the water enters is entirely removed and separate from the steam and all working parts.

The long cylinder at the bottom of the regulator is a dashpot, the piston of which is connected with the main valve of the regulator, thereby preventing sudden and violent "jumping" of the pump when the pressure suddenly changes.

For automatic fire sprinkler service they have been found especially valuable, as the valve is thrown wide open immediately the slightest drop in pressure occurs. On application we can refer parties where they are in use.

Manufactured by Mason Regulator Co., Boston, U. S. A.

The Mason Regulator Co., = Boston, U. S. A.



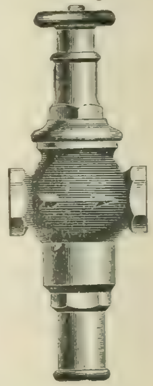
The Mason Pump Governor.

The Mason Pump Governor is to the direct acting steam pump what the ordinary ball governor is to the steam engine. It attaches directly to the piston rod of the pump and operates a balanced valve placed in the steam pipe, thereby exactly weighing the amount of steam to the needs of the pump, and economizing the same. By using the Mason Governor, you can instantly set or change your pump to any required speed, which will be maintained in spite of variation in load or steam pressure. As all the working parts of the governor are immersed in oil, the wear is reduced to a minimum. It is largely used on vacuum pumps, deep well pumps, water works pumps, ice machines, and all classes of pumps requiring an uniform stroke.

Louisiana Sugar Refining Co., New Orleans, La.

The Mason Governors which you furnished for our vacuum pumps, are working to my entire satisfaction, maintaining a uniform speed under the varying conditions of steam pressure, etc. The Mason Reducing Valves, furnished for our Granulators, are also giving excellent results.

Yours truly, GEO. O. EASTWICH, Supt.



The Mason Locomotive Reducing Valve.

This reducing valve has been in use by the leading steam car heating companies for the last five years. During that time over 5000 have been placed on nearly every railroad which has adopted steam heat. One feature which will commend itself to every engineer is the self-locking device, which enables the valve to be set for any pressure, and automatically locked. In the manufacture of this valve there is no attempt made to save on stock in order to cheapen the price. Every valve is made of the best steam metal, and will not steam-cut at a pressure of 180 lbs. As we supply a large number of car-heating and railroad companies, each of whom use different connections, we are prepared to furnish different sizes.

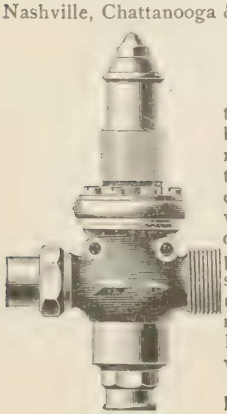
This valve is the standard on 125 railroads.

MASON REGULATOR CO., BOSTON :

Dear Sirs :—I have just put two of your regulators on our passenger engines, and I am very much taken up with them, and like their working.

I am, yours respectfully, OTTO BEST, Nashville, Tenn.

Nashville, Chattanooga & St. Louis Ry.



The Mason Air Brake Pump Regulator.

This is constructed on the same principle as our pump pressure regulator, but with a few small changes, so as to allow of its application to air brake pumps without changing the fittings on the locomotive. It is only necessary to place these in the steam pipe leading to the pump and connect the air pressure pipe with the train service pipe. As the air chamber is entirely separate from the steam and working parts, any particles of dirt which may get into the main service pipe cannot get into the working parts of the regulator and thence into the pump, neither can the steam and air pressure have access to each other. The regulator is fitted with couplings, so that no change in piping will be necessary in substituting it for those now in use. These regulators are the standard on more than thirty railroads. Among those using large quantities we refer to the Pennsylvania, Boston and Albany, Chicago, Rock Island and Pacific, Richmond and Danville, Chesapeake and Ohio, Fitchburg, etc.

We will send one on trial to any railroad. Weight, with couplings, $8\frac{1}{2}$ lbs. Price, $15.00 net.

Manufactured by Mason Regulator Co., Boston, U. S. A.

ESTABLISHED 1831. **ANNUAL CAPACITY, 1000.**

Baldwin Locomotive Works,

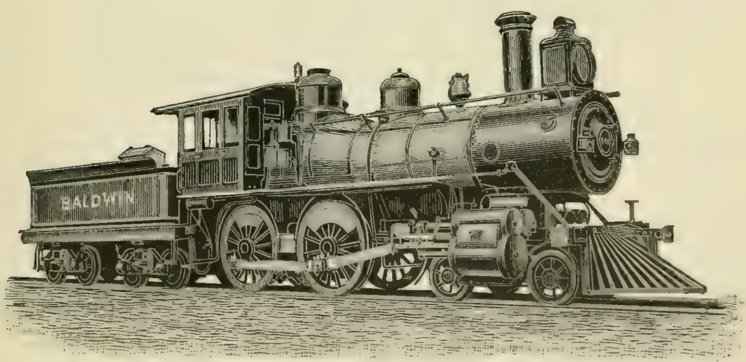
BURNHAM, WILLIAMS & CO., Prop's,

PHILADELPHIA, PA.,

MANUFACTURERS OF

Locomotive * Engines,

Adapted to every variety of service, and built accurately to standard gauge and templates. Like parts of different engines of the same class perfectly interchangeable.



Singe=Expansion and Compound Locomotives.

Broad and Narrow Gauge Locomotives; Mine Locomotives by steam or compressed air; Plantation Locomotives.

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ALL WORK THOROUGHLY GUARANTEED.

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BURNHAM, WILLIAMS & CO.,
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CHESTER STEEL CASTINGS Co.

Steel Castings of Every Description

FROM 1 to 40,000 POUNDS WEIGHT

OF OPEN HEARTH, CHESTER OR BESSEMER STEEL.

TRUE TO PATTERN. SOUND. SOLID.

Locomotives: Such as Driving Wheels, Cross Heads, Axle Boxes, Rocker Arms, Links, Blocks, Driver Boxes, Piston Heads, &c.

Cars: Such as Steel Wheels and Tyres, Couplers, Knuckles, Duffers, Bumpers, Pedestals, Journal Boxes, Brake Blocks and Shoes, Brake and Ratchet Wheels Seat Backs, &c.

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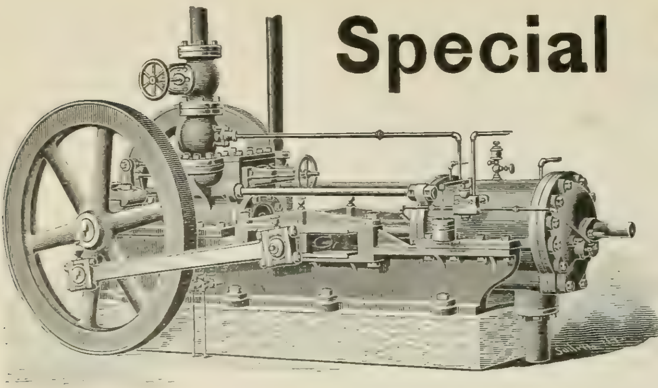

Special Notice

The HIGHEST AWARD OF THE JUDGES AT THE World's Columbian Exposition, Chicago,

Was given to the Ingersoll-Sergeant Drill Company for the following exhibits:

Ingersoll-Sergeant Corliss Cross-Compound Air Compressor with Independent Condenser.
Ingersoll-Sergeant Piston Inlet Cold Air Compressor, Straight Line Pattern.
Ingersoll-Sergeant Stone Channeling Machine.
Ingersoll-Sergeant Bar Channeler.
Ingersoll Standard Gadder.
Sergeant Double Bearing Universal Joint Quarry Bar.
Sergeant Lewis-Hole Tripod.
Ingersoll-Sergeant Rock Drill.
Sergeant Sappet Drill.
Sergeant " Baby Drill.
Ingersoll-Sergeant Coal Mining Machine.
Sergeant Adjustable Tunnel Column.
Ingersoll Single Screw Shaft Bar.
Sergeant Arm Clasp.
Sergeant Air Head.
Electric Blasting Battery.

Making 16 Awards in All.

INGERSOLL - SERGEANT DRILL CO.

HAVEMEYER BUILDING.

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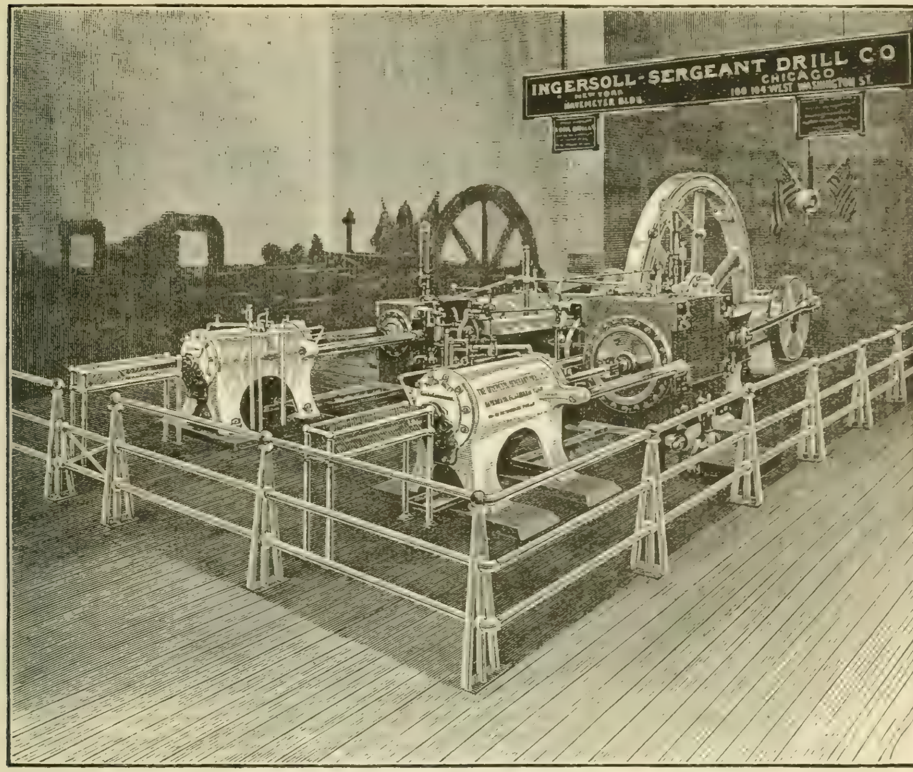
56 South Water Street, Cleveland, Ohio.
20 South 20th Street, Birmingham, Ala.
1728-1724 California St., Denver, Colo.
259 Main Street, Salt Lake City.
300-302 Main Street, Butte, Mont.
45 First Street, Portland Ore.
245 Front Ave., Spokane, Wash.
21-23 Fremont Street, San Francisco, Cal.
219-221 Main Street, Anaconda, Mont.



Compound Condensing Corliss Air Compressor

WITH PISTON INLET COLD AIR CYLINDERS.

Used in service plant at the World's Columbian Exposition, Chicago, and **AWARDED THE FIRST PRIZE BY THE JUDGES.** This large Duplex Air Compressor was located in section F, No. 33, Machinery Hall, and was used by the World's Fair Commissioners to supply Exhibitors with Compressed Air Power. Among these exhibitors were the Baldwin Locomotive Works and the Westinghouse Air Brake Companies, having Locomotives and Air Brakes in full operation by means of Compressed Air.

DIMENSIONS: High Pressure Steam Cylinder, 18 in. Bore, 42 in. Stroke.
Low Pressure Steam Cylinder, 34 in. Bore, 42 in. Stroke.
Two Air Cylinders, each 18¼ in. Bore, 42 in. Stroke.

BUILT BY

The Ingersoll-Sergeant Drill Co., New York.

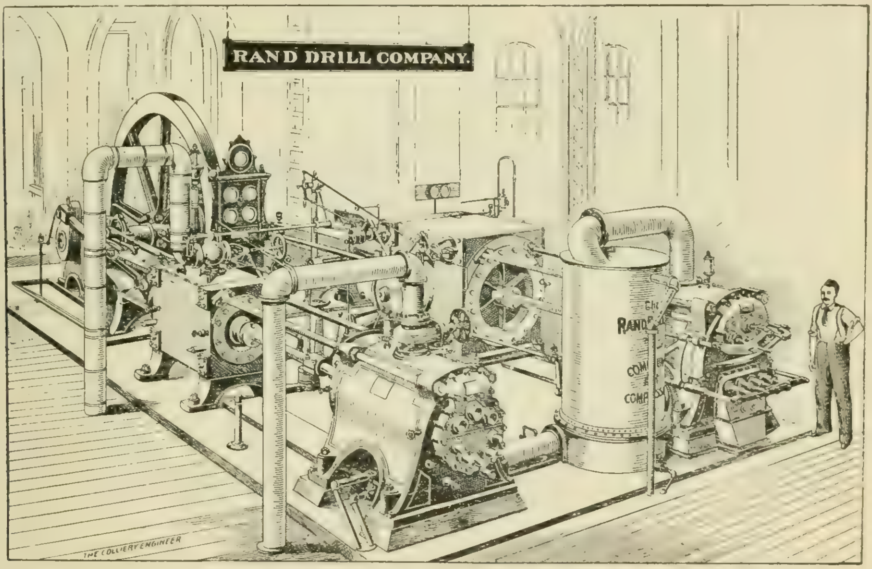
Similar plants furnished to the Lehigh and Wilkes-Barre Coal Co., Plymouth, Penna.; Aurora Iron Mining Co., Ironwood, Mich.; Ashland Iron Mining Co., Ironwood, Mich.; Colley Mine, Bessemer, Mich.; Germania Iron Mining Co., Hurley, Wis.; Highland Mining Co., Lead, So. Dakota; Livonia Salt Co., Livonia, New York; The New Reitfontein Estate Gold Mines, L't'd, Johannesburg, So. Africa; Wemmer Gold Mining Co., L't'd, Johannesburg, So. Africa; Van Ryn Gold Mining Co., L't'd, Johannesburg, So. Africa; Ginsberg Gold Mining Co., Johannesburg, So. Africa; Henry Nourse Gold Mining Co., Johannesburg, So. Africa; Herriot Gold Mining Co., Johannesburg, So, Africa, and others.

RAND DRILL COMPANY,

Manufacturers of

AIR COMPRESSORS.

Below is cut of Air Compressor built by us for World's Columbian Exposition. It has Compound Condensing Corliss Steam Engine and Compound Air Cylinders, capacity 2500 ft. free air per minute.



We are building compressors embodying the highest and most advanced construction, both as regards the compressors and engines driving them, to furnish compressed air at the lowest cost of production.

We have compressors in use delivering air at pressures of from fifteen pounds to five thousand pounds.

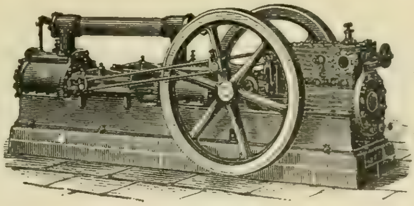
Correspondence solicited for compressors for all pressures.

RAND DRILL COMPANY,

23 Park Place,

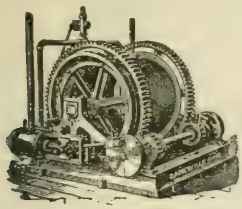
N. Y. City, U. S. A.

AIR AND GAS COMPRESSORS.

ALL  PRESSURES.

THE NORWALK IRON WORKS CO.

CIRCULARS. SOUTH NORWALK, CONN.



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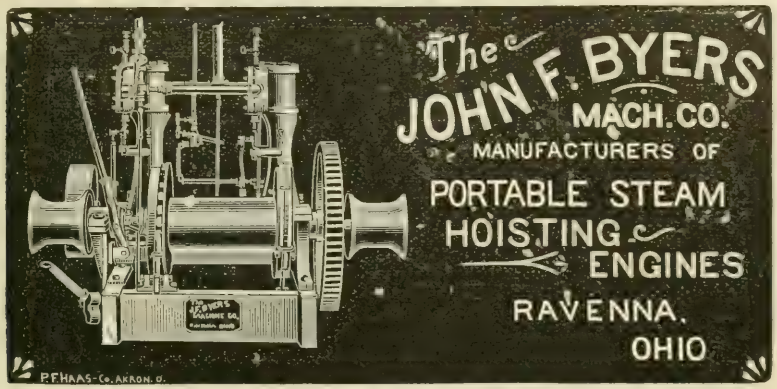
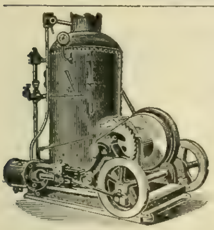
Quartz Mills, Hoisting Engines, Miners' Prospecting Engines, Safety Cages, Mining Cars, Etc.

Plans and Estimates for Machinery of First-Class Stamp Mills, Batteries, Amalgamating Pans, Settlers, Furnaces, Revolving Dry Kilns, Retorts, Clean-up Pans, Engines, Boilers, and Rock Breakers, Shafting, Pulleys, and Gearing.

During the past three years we have furnished the Machinery for many of the largest Gold and Silver Quartz Mills in the West. Our Hoisting Engines are in use at over 100 Silver Mines in the West and Coal Mines in Ohio. We also manufacture first-class Portable Engines and Sawmills.

GRIFFITH & WEDGE CO., Zanesville, O.





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MANUFACTURERS OF

STEAM, HORSE AND HAND POWER **HOISTING MACHINES**

Derrick Iron and Contractors' Supplies.

A Complete and Very Useful Catalogue Free. Mention this Magazine.

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For testing mineral lands, well driving, soundings for bridge foundations, etc. Cores taken of strata bored through. Machines leased on reasonable terms. Experienced operators supplied. Diamond Bit Setting a specialty.

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ARE NEXT TO

Diamond in Hardness.

GRIND MATERIALS THAT DESTROY OTHER STONES.

They are made from Blocks of Emery cast or imbedded in Metal, thus an Ideal Grinding Face is obtained.

The Emery, incomparably hard, is always sharp, never glazes, and the softer metal between the blocks makes a

Honey=Combed Face,

more effective than the best French Buhr.

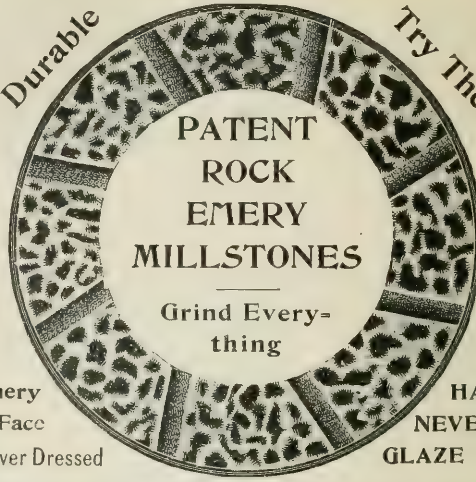
Wherever Buhrs do well these do better.

Fit Any Millstone Frame.

FASTEST **GRINDER** KNOWN

Durable

Try Them



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The Best Grain Stone, and the Only One that Never Requires to be Sharpened.

The Finest Grinder and Most Durable Stone for Minerals.

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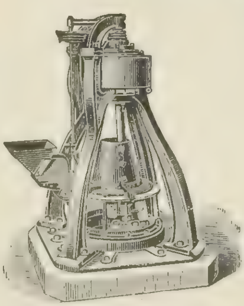
The Only Perfect Pulverizer



Of QUARTZ, GOLD OR SILVER ORES, PLUMBAGO, PORTLAND CEMENT, PHOSPHATE ROCK, FOUNDRY FACINGS, And All Other Refractory Substances.

Will work either wet or dry, and deliver finished product. Capacity 3 to 4 tons per hour on Phosphate Rock, 1½ to 2 tons per hour on Portland Cement, Quartz or Ores, depending on hardness of material to be pulverized and fineness of product. Grinds from 30 to 250 Mesh with equal facility.

No Journals in Grinding Chamber. Ball rigid on shaft having direct positive action on material. Minimum power produces maximum amount of product. It is absolutely guaranteed in every respect, both as to construction and capacity. First cost, wear, and operating expense much less than stamp mills. Large number of mills in use on different materials with positive success in every instance.

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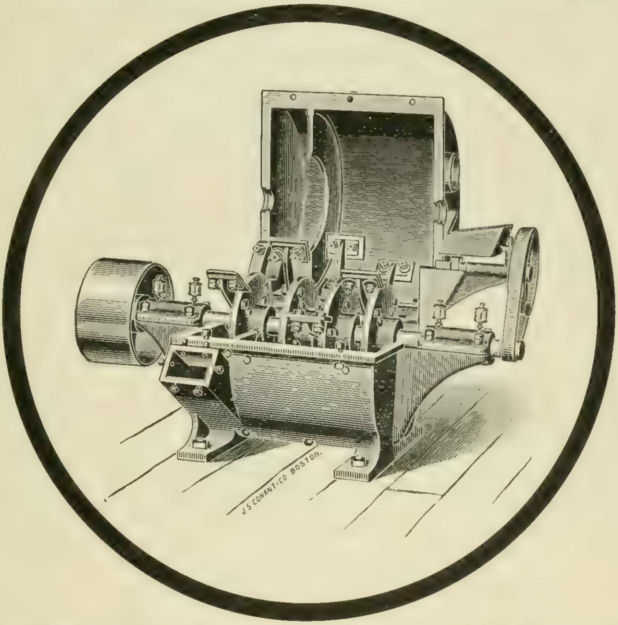
"No other method of pulverizing is comparable to this."

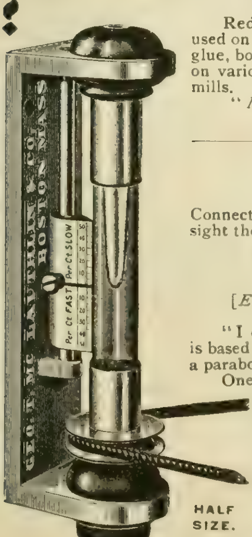
"We have found nothing superior to the Magic Pulverizer for pulverizing sugar."
E. A. CUSHING, *Supt.,*
Walter Baker & Co., Chocolate Mfrs., Dorchester, Mass.



"I am perfectly willing to answer any inquiries regarding them, and will endeavor to place them on their proper basis of merit.
J. B. McDONALD, Treas.,
Asbestos Paper Co., Boston.

"The variety of kinds of material these machines will handle exceeds anything in my experience of thirty years of general grinding. BENJ. RANDALL, *East Boston, Mass., Fertilizers, Etc.*

THE MAGIC PULVERIZER.



HALF SIZE.

Reduces refractory materials to impalpable powder, or any grade. It is successfully used on a wonderful variety of materials, including minerals, ores, mica, black-lead, coal, glue, bones, hoofs, asbestos, cotton oil cake, sugar, roots, chemicals, fertilizers, etc., and on various substances which from dampness, toughness or hardness have resisted all other mills.

"I know them to excel all other machines, both in capacity and execution."
W. H. GAFFETT, Supt., Giant Powder Co., San Francisco, Cal.

$5 SPEED GAUGE.

PATENT GRANTED.

Connected to engines, dynamos, motors, shafting or any machine, shows continously at sight the speed and all variations.

SIMPLE. ACCURATE. DURABLE.

[*Extract from letter of J. G. Henderson, Esq., Engineer in Chief, General Electric Co., N. Y.*]

"I consider this SPEED GAUGE a *most accurate and useful little instrument.* It is based on the well-known law that the surface of a liquid in rotation assumes the form of a parabola being acted upon horizontally by centrifugal force and vertically by gravity.

One of these instruments suitably connected to an engine (or other machine) *will show whether the speed is up to the mark at a glance,* the index being set to correspond to the normal number of revolutions per minute. The Gauge gives the best results when driven at a high speed, when a very *small variation makes quite a difference in the indication.*

Most tachometers have springs, levers, and other mechanism — all of which are liable to get out of order, but this one has only the very simple parts necessary to bring it into action, and *is based on two fundamental physical laws which cannot possibly change.*"

A. J. BECKLEY & CO.

Manufacturers of

Perforated Sheet Metal

OF ALL KINDS, FOR ALL USES,

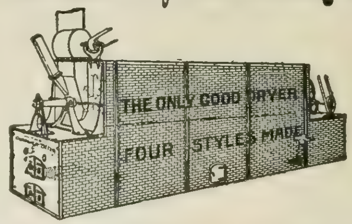
MERIDEN, CONN.

For Coal and Ore Separators, Revolving Screens, Jigs, Washers, Stamp Batteries, Mining and Smelting Works, Silver Reduction and Concentrating Works, Water Works, Spark Arresters, Etc., Etc. AND ALL KINDS OF GRAIN CLEANING MACHINERY: for Centrifugals, Wool and Sugar Machinery, Purifier Trays for Gas Works, Coal and Coke Works, Flour, Cotton, Oil, Paper and Pulp Mills.

PERFORATORS OF ALL METALS FOR ALL USES.

SEND FOR CATALOGUE.

The Cummer Dryer and Calcining Apparatus.



Four styles of Dryers made, each in Five different sizes.

DRIES Sand, Marl, Ores, Phosphate, Clays, Infusorial Earth, Etc., Etc.

CALCINES Ores, Paint Stocks, Phosphate, Gypsum, Etc., Etc.

The F. D. Cummer & Son Co., Arcade, Cleveland, OHIO, U.S.A.

THE SULLIVAN DIAMOND PROSPECTING DRILL

The **DIAMOND DRILL** is invaluable for the preliminary testing or later development of mineral property. It bores to **any depth at any angle**, and removes a **solid core** or section showing the **location, thickness** and **quality** of the **mineral**.

THE QUICKEST, CHEAPEST & BEST METHOD OF PROSPECTING.
THE MOST ACCURATE & RELIABLE RESULTS.

Diamond Drills operated by Hand or Horse Power, Steam, Compressed Air or ELECTRICITY.

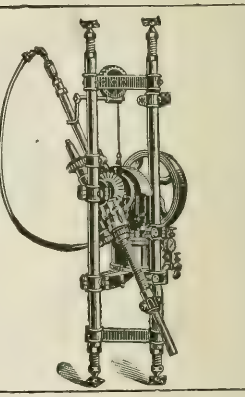
GENERAL QUARRYING MACHINERY — Channeling and Gadding Machines.

COAL MINING MACHINERY—The Stanley Entry Driving Machine.

Contractors for Prospecting Mineral Lands with the Diamond Core Drill.

SULLIVAN MACHINERY CO.,

54-60 N. Clinton St.	18 Broadway,	18th & Market St.
CHICAGO, ILL.	NEW YORK.	DENVER.



"E" Drill for Prospecting Underground.

THE MAGIC CRUSHER

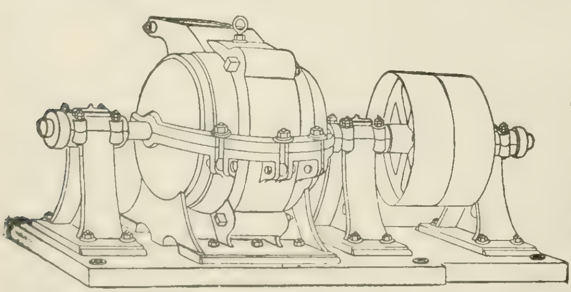
"I know them to excel all other machines, both in capacity and execution."

REDUCE REFRACTORY MATERIALS TO
NUT SIZE OR SIZE OF SAND. | IMPALPABLE POWDER OR COARSER GRADE.

GEO. T. McLAUTHLIN & CO., 120 Fulton St. BOSTON, MASS.

"No other method of pulverizing is comparable to this."

THE MAGIC PULVERIZER



For the reduction to fine powder of cement rock, fertilizers, ores and other substances, no machine equals in efficiency, durability and economy the Frisbee-Lucop Mill. Proved by seven years' continuous use. Mills on exhibition in this city. Frisbee-Lucop Mill Co., 136 Liberty St., New York.

JESSOP'S STEEL

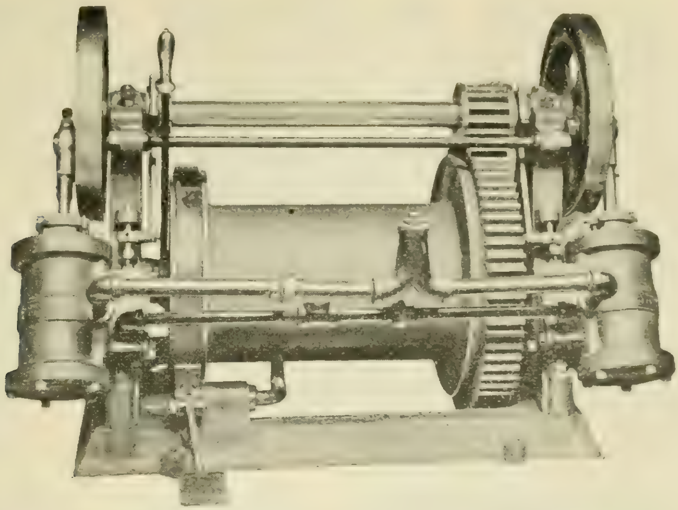
For TOOLS, DRILLS, DIES, SAWS, &c.

ALL KINDS IN STOCK.

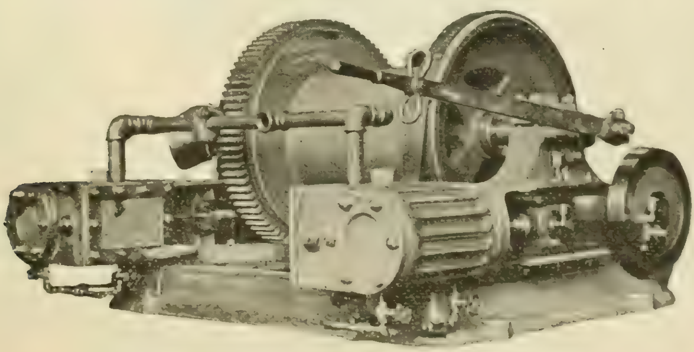
Gold Medal, Paris, 1889.

WILLIAM JESSOP & SONS, L'd. | MANUFACTORY, SHEFFIELD, ENGLAND. | Chief American Office, 91 JOHN ST., NEW YORK.

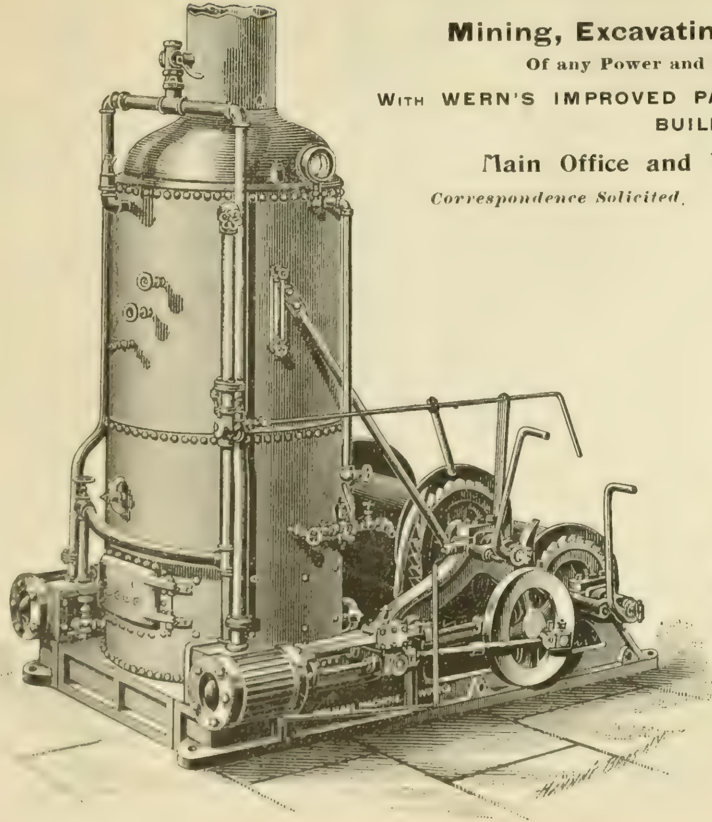
W. F. WAGNER, Gen'l Manager.

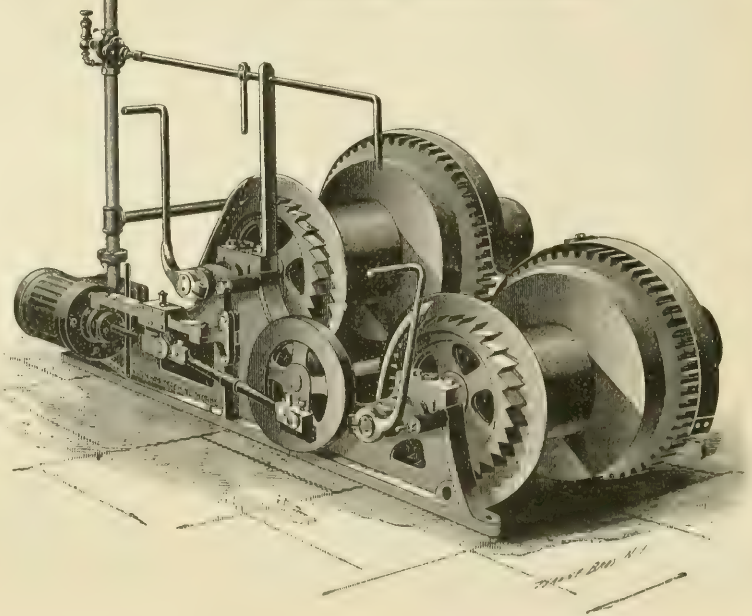


DOUBLE CYLINDER SPECIAL FRICTION DRUM HOISTING ENGINE
FOR LIGHT WORK.



DOUBLE CYLINDER FRICTION DRUM HOISTING ENGINE.





Advertising—
And its Results.

During the past several years the Berlin Iron Bridge Co., of East Berlin, Conn., have advertised more extensively and continuously than any other bridge building or structural iron firm in the history of the business. They have in fact made themselves conspicuous and notable by the liberality of their policy in that particular.

The result is very clearly indicated in the following extract from a letter from them addressed to the Editor of The Engineering Magazine, under date of August 15, 1893.

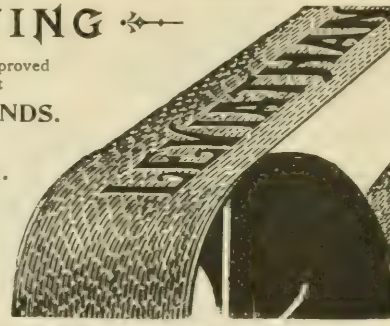
"In times like these, when so many manufacturing concerns are complaining of hard times and lack of orders, it is encouraging to find that there is occasionally one which is running full time and has plenty of orders. We are running our entire plant full time and portions of the works overtime, and have contracts for a large amount of work, including a new electric light and power station at Lynn, Mass. ; a drawbridge at Salem, Mass. ; a new foundry building for the New Home Sewing Machine Co., at Orange, Mass. ; an iron building to go to Tampa, Fla. ; a large bridge for Chester County, Pa. ; a new iron storehouse for the New York Knife Co., at Walden, N. Y. ; a large power plant for the Philadelphia Traction Co. ; a large cotton shed for the Southern Pacific Railroad Co., at New Orleans, La. ; a new roof for the purifier-house of the Northern Liberties Gas Co., at Philadelphia ; a new power house for the Reading (Pa.) Traction Co. ; a new power-house for the State Street Horse Railway Co., at New Haven, Conn. ; a car-barn for the Easton Transit Co., at Easton, Pa. ; and a large smelter building for the Anaconda (Mont.) Smelting Co. Besides these we have numerous small jobs scattered throughout the country, which will employ our entire plant until after January 1. We seem to be particularly fortunate in securing work like this at this time."

During 1893 The Berlin Iron Bridge Co., carried a half page advertisement in the The Engineering Magazine, and they have now contracted to increase it to a full page for 1894. It will be observed that they make a six-page display in our World's Fair number.

From Benjamin R. Western, Advertising Expert, New York :

"You will be pleased to know that our clients, who have freely used The Engineering Magazine for advert since its first issue, are well satisfied with it, as evidenced by the regularity with which their announcements appe A consideration of the Magazine's constituency must satisfy any thinking advertiser of its paying qualities."

LEVIATHAN BELTING



Tested under the hardest possible conditions and proved by years of service to be the best possible belt

FOR HEAVY DRIVING OF ALL KINDS.

Proof against Heat, Steam and Water.

Strength, Durability and Traction Power Unequalled.

SOLE MANUFACTURERS,

MAIN BELTING CO.,

1219-1235 CARPENTER ST., PHILADELPHIA.

248 RANDOLPH ST., CHICAGO.

120 PEARL ST., BOSTON.

Send for Price-Lists and Samples.

HOME RUBBER CO.,

MANUFACTURERS OF

THE HIGHEST GRADE OF

MECHANICAL RUBBER GOODS,

TRENTON, N. J.

J. O. STOKES, TREASURER AND GENERAL MANAGER.

BELTING, HOSE, PACKING, VALVES, SPRINGS, MATTING, PERFORATED MATS, STEP TREADS, TUBING, GASKETS.

Our Celebrated Brands, } "Black Seal," "White Cross," "Tiger," "World."

Our "Black Seal," "White Cross," "Tiger" and "World" Brands of Goods are acknowledged by all to be absolutely the best grades manufactured.

E. L. PERRY, Prest. W. G. WINANS, Treas

Peerless Rubber M'f'g Company,

Patentees and Sole Manufacturers.

Two sizes—$\frac{1}{2}$ and $\frac{5}{8}$. Fit any man hole or hand hole in the world · $\frac{3}{8}$ for unions.

Rainbow Sheet and Flange Packing.

Peerless Piston and Valve Rod Packing.

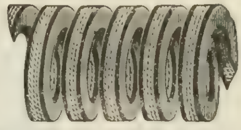
C. H. Dale, Gen'l Agent, 15 Warren Street, New York.

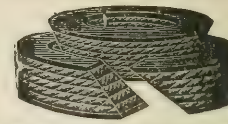
TRADE GARLOCK. MARK.

Garlock Packings.

PATENTED.

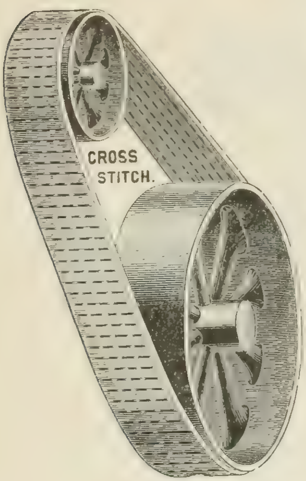
We especially invite the attention of parties in need of a High Grade Packing to the various articles which we manufacture. The Elastic Ring, Sectional, Spiral and Special Water Packings. Will not melt or blow out. Tested





to stand intense heat. Economical, Reliable and Durable. Engineers order our Special Water Packing which we guarantee to please you. Beware of imitations. Correspondence solicited.

Main Offices: Palmyra, N.Y. Rome, Ga. Omaha, Neb. **The Garlock Packing Co.** New York, 136 Liberty St. Chicago, 94 Franklin St. Phila., 28 N. 5th St. Pittsb., 99 1st Av. St. Louis, 415 Morgan St.



CROSS STITCHED BELTS.

WITHOUT SEAM

The Latest Improvements in Rubber Belting.

Cannot Separate Between the Plies.

Equal Tension on All Stitches.

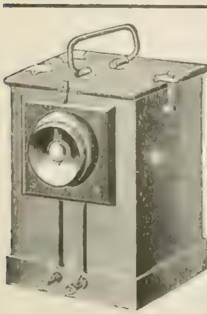
Cannot Break the Stitches in Running Over Small Pulleys.

SEND FOR ILLUSTRATED PAMPHLET.

BOSTON WOVEN HOSE AND RUBBER CO.

BOSTON. CHICAGO. ST. LOUIS. SAN FRANCISCO.

THE NEWTON RUBBER WORKS.



BATTERY JARS MADE BY SPECIAL PROCESS.

Thoroughly Acid-Proof.

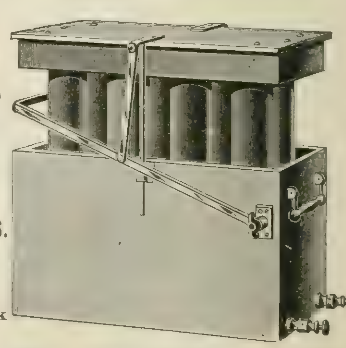
STRONGEST. LIGHTEST.

Salts cannot "creep."

EXCLUSIVE M'F'RS HEUSTIS PATENT BICYCLE TIRES.

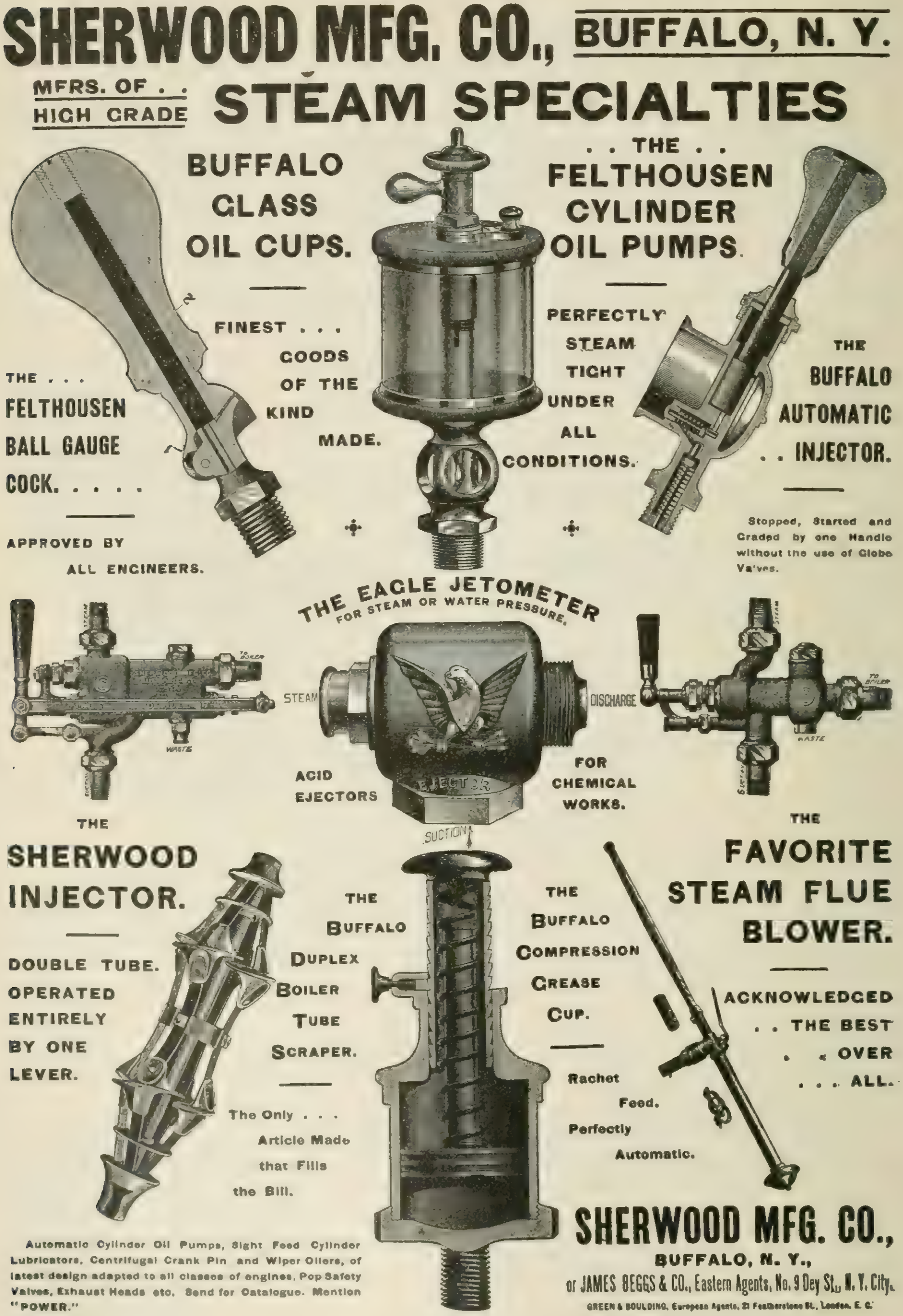
Pneumatic and Cushion Tires, and Bicycle Pedals.

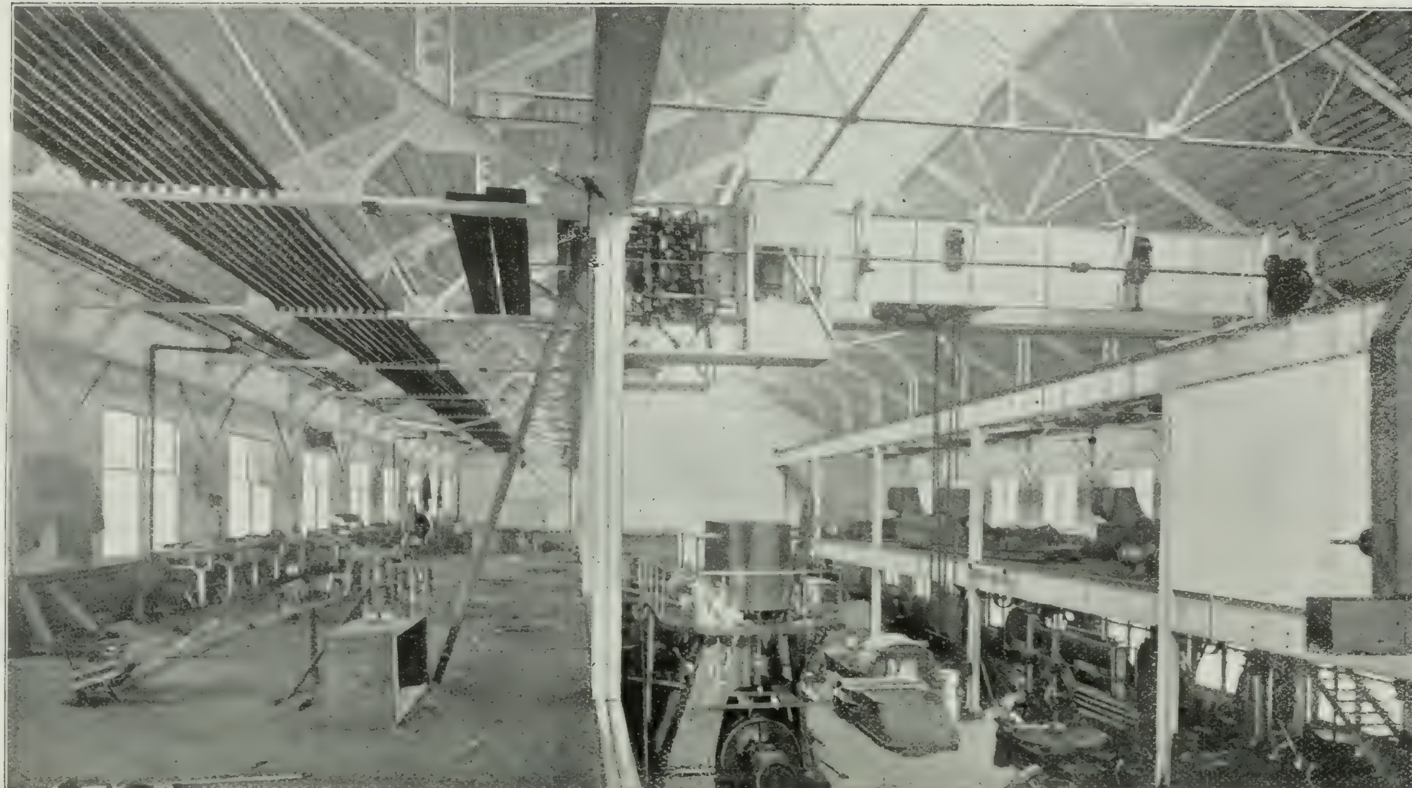
Hard and Soft Rubber Mould Work of all kinds.



Factory, Newton Upper Falls, Mass. Office, 178 Devonshire St., Boston.

Please mention The Engineering Magazine when you write


SHERWOOD MFG. CO., BUFFALO, N. Y.
MFRS. OF . . HIGH GRADE
STEAM SPECIALTIES
BUFFALO GLASS OIL CUPS.
FINEST . . . GOODS OF THE KIND MADE.
. . THE . . FELTHOUSEN CYLINDER OIL PUMPS.
PERFECTLY STEAM TIGHT UNDER ALL CONDITIONS.
THE . . . FELTHOUSEN BALL GAUGE COCK. . . . .
APPROVED BY ALL ENGINEERS.
THE BUFFALO AUTOMATIC . . INJECTOR.
Stopped, Started and Graded by one Handle without the use of Globe Valves.
THE EAGLE JETOMETER
FOR STEAM OR WATER PRESSURE.
STEAM
DISCHARGE
SUCTION
ACID EJECTORS
FOR CHEMICAL WORKS.
THE SHERWOOD INJECTOR.
DOUBLE TUBE. OPERATED ENTIRELY BY ONE LEVER.
THE BUFFALO DUPLEX BOILER TUBE SCRAPER.
The Only . . . Article Made that Fills the Bill.
THE BUFFALO COMPRESSION GREASE CUP.
Rachet Feed. Perfectly Automatic.
THE FAVORITE STEAM FLUE BLOWER.
ACKNOWLEDGED . . THE BEST . . OVER . . . ALL.
Automatic Cylinder Oil Pumps, Sight Feed Cylinder Lubricators, Centrifugal Crank Pin and Wiper Oilers, of latest design adapted to all classes of engines, Pop Safety Valves, Exhaust Heads etc. Send for Catalogue. Mention "POWER."
SHERWOOD MFG. CO.,
BUFFALO, N. Y.,
or JAMES BEGGS & CO., Eastern Agents, No. 9 Dey St., N. Y. City.
GREEN & BOULDING, European Agents, 21 Featherstone St., London, E. C.



DESIGNED AND BUILT BY THE BERLIN IRON BRIDGE COMPANY, EAST BERLIN, CONN.

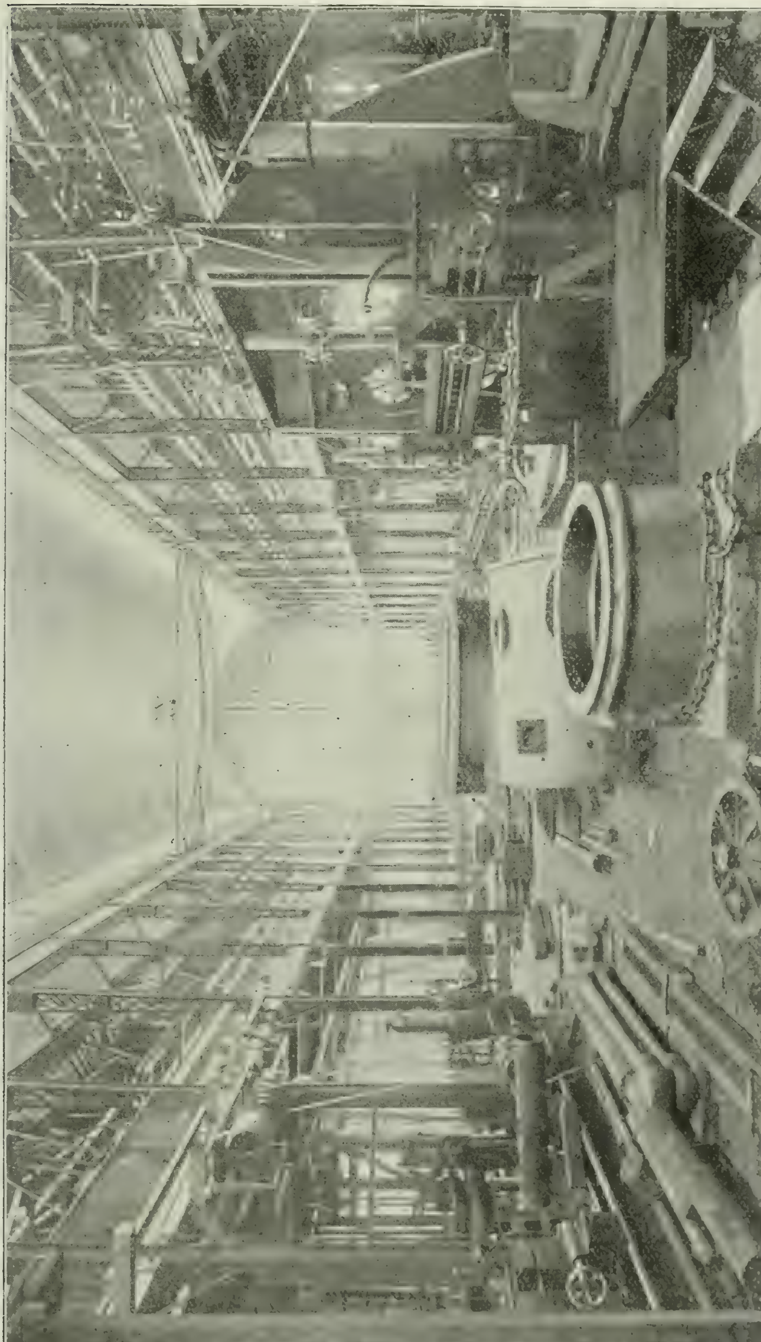
Machine Shop, J. Morton Poole, Wilmington, Del. Building 78 feet wide and 157 feet long. Central portion 36 feet wide and one story high, controlled by a Traveling Crane. Wings each 21 feet in width, two stories high. Major portion of the light in centre of the building secured through the skylight.

DESIGNED AND BUILT BY THE BERLIN IRON BRIDGE COMPANY, EAST BERLIN, CONN.

Main Truss Shop of Berlin Iron Bridge Co's. works, East Berlin. Building 80 feet wide and 400 feet long, made of Iron and Glass. Interior lighted by a skylight from roof and glass along sides and ends. Roof designed to carry heavy loads, every roof truss has trolley attached for moving material across the shop. Around each man are heavy overhead travelers for moving the work.

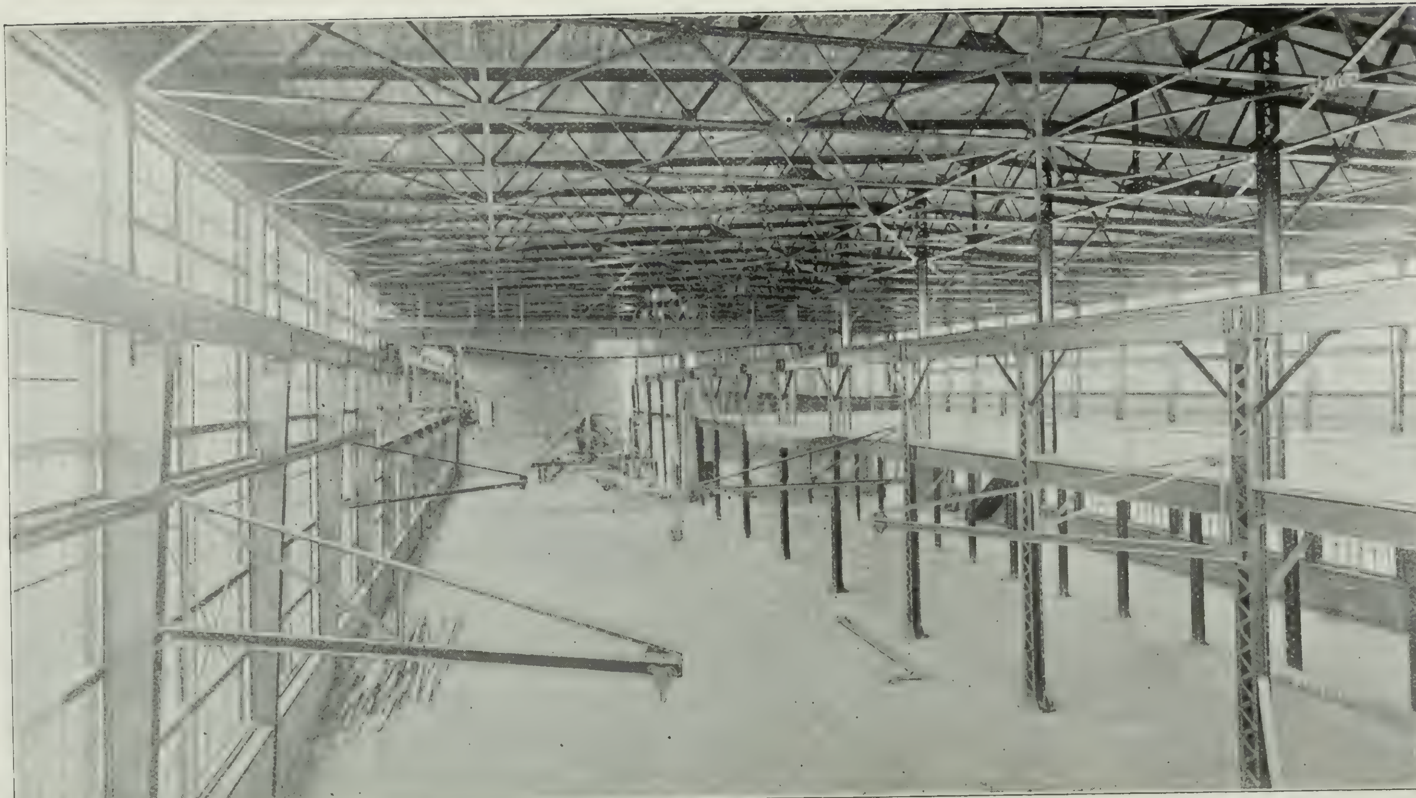
DESIGNED AND BUILT BY THE BERLIN IRON BRIDGE COMPANY, EAST BERLIN, CONN.

Foundry Building. Waterbury Farrel Foundry & Machine Co., Waterbury, Conn. Building 78 feet wide and 200 feet long. Power for moving heavy castings, moulds, etc., is by means of jib cranes instead of by power cranes.



DESIGNED AND BUILT BY THE BERLIN IRON BRIDGE COMPANY, EAST BERLIN, CONN.

Machine Shop, The Dickson Mfg. Co., Scranton, Penn. Building 100 feet wide and 400 feet long; central portion under the traveling crane 51 feet wide and wings 24 feet 6 inches in width. The interior is lighted by side lights above the traveling crane girders and by a skylight in the roof.



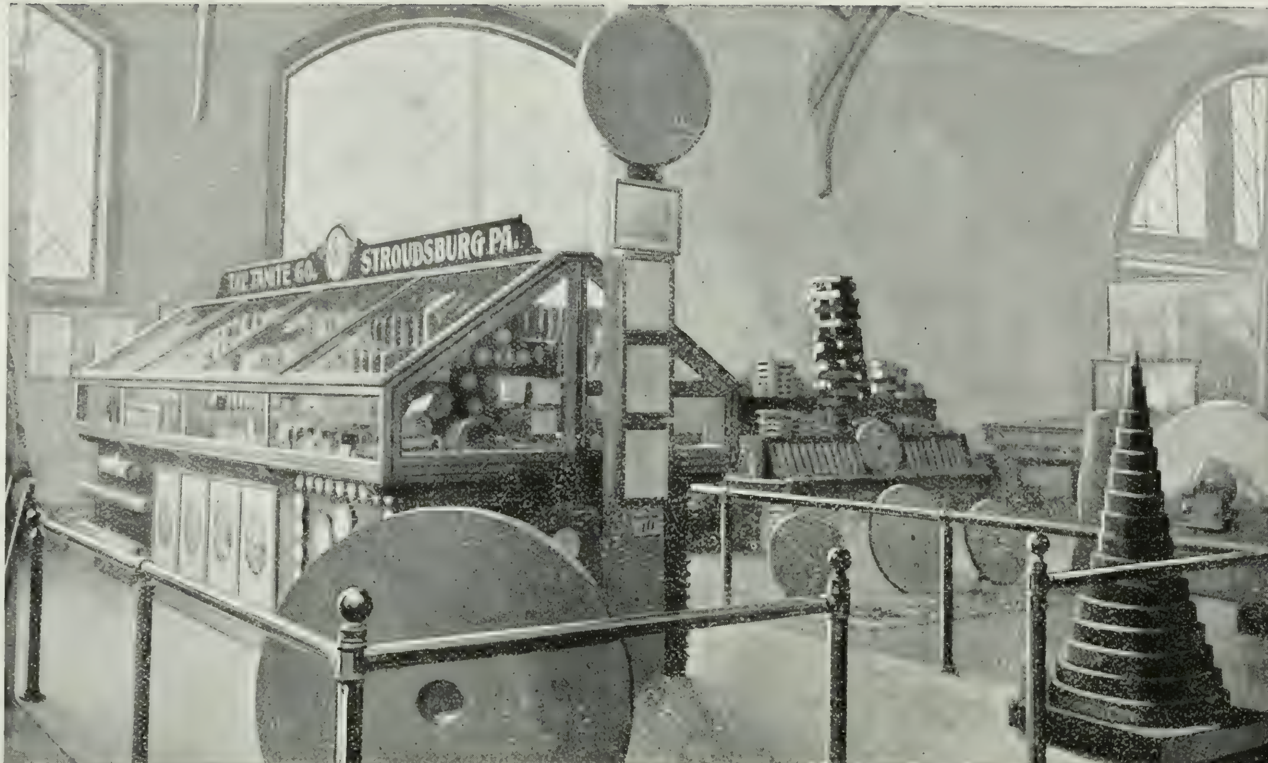
DESIGNED AND BUILT BY THE BERLIN IRON BRIDGE COMPANY, EAST BERLIN, CONN.

Machine Shop, Fuller Iron Works, Providence, R. I. Sides of building made entirely of iron and glass. Building 50 feet wide under the traveling crane, 40 feet wide in the gallery, and 220 feet long. Interior so lighted that fine work can be done in any part of the shop, even on dark days, and ventilation is so perfect that the interior of the building is not excessively warm even in hot weather.

DESIGNED AND BUILT BY THE BERLIN IRON BRIDGE COMPANY, EAST BERLIN, CONN.

Power Plant, Lynn Gas & Electric Co., Lynn, Mass. Building 154 feet wide and 158 feet long. Dynamo room has a Crane traveling full length of the building. Engine and boiler room ventilated from ridge by Improved Ventilator, with corrugated iron shutters opening and closing by cords from floor. Boiler room covered with Patent Anti-Condensation Corrugated Iron Roof Covering, guaranteed to be fire-proof.

See advertisement on page 89.



. . MEMENTO OF . .

The Tanite Company's Educational Exhibit
OF ABRASIVES.

Columbian Exposition, 1893.

GROUP 45.—Class 297. Grinding, Abrading and Polishing Substances, Grindstones, Hones, Whetstones, Grinding and Polishing Materials, Sand, Quartz, Garnet, Crude Topaz, Diamond, Corundum, Emery in the Rock and Pulverized, and in assorted sizes and grades.

See Advertisement on page 89.

A UNIQUE EXHIBIT.

In Machinery Hall, at Chicago, several Emery Wheel makers have full and interesting exhibits of a commercial character. The Tanite Co., of Stroudsburg, Pa., was requested by the Exposition authorities to treat "Abrasives" from an educational standpoint. The exhibit here illustrated and described is the result, and its compact character is due to the fact that the exhibit will be presented as a gift to The Smithsonian, the Chicago University, or some other suitable institution. While some of the articles were furnished by The Tanite Co., many were contributed by liberal minded manufacturers.

Emery, being the most important Abrasive, is illustrated fully. Emery Ore is shown from Turkey, Greece and the United States. In one piece clear blue Sapphire can be seen with the naked eye. On a platter of pure Aluminum are shown Sapphires, Corundum and Emery, with the explanation that Alumina is the Oxide of Aluminum, and that the articles on the platter are largely composed of Crystallized Alumina, the Sapphire being almost pure Alumina. Emery is then shown in its successive stages—first, as it comes from the crusher; then in the form of grain and flour; then as polish, (powder, liquid and paste;) and, lastly, in the shape of whet stones and solid emery wheels. Fragments of various classes of Tanite wheels are displayed to show the internal texture. There are bottles containing the dust gathered under Tanite Wheels after the grinding of cast, malleable and wrought iron, and of brass and steel. These are for experimental examination with magnifying glass and magnet. "Petrified Sparks" are an interesting feature. These are strangely shaped cones formed of the matter which fuses below an emery wheel when grinding under heavy pressure. The comparative products of the emery wheel, file and cold chisel are tabulated on a framed sheet, while the case contains pieces of cast-iron and saw-steel with the cuts made by file and wheel. The piece of saw-plate demonstrates that in a given time the wheel did 126 times as much work as the file. In the case and on the ends of the stand are numerous parts of machines, all of which have been surfaced by the Newman Emery Planer. These appear to be as true as if planed, and tabulation shows that this machine has taken a maximum cut $\frac{1}{4}$ of an inch deep, and has taken a $\frac{1}{16}$ inch cut over a surface of 100 square inches in 6 minutes and 9 seconds. Its ordinary cut is from $\frac{1}{64}$ to $\frac{1}{32}$ inch.

Emery wheels are usually thought of in connection with metal grinding, but in this case are shown blanks for Long Combs and Ladies' Back Combs, made of Vulcanite, and other samples showing that the Long Comb has been edged and the Back Comb had the spaces between the teeth cut out with Tanite Wheels. Glass Guides from a Silk-Spinning Mill are also shown. In these guides the silken thread wears a tapering groove which eventually breaks the thread, and these grooves are ground out by the use of Tanite Wheels.

As curious and instructive examples of abrasion, the parts of various machines used in The Tanite Factory are shown, all testifying to unequal and destructive wear due to unequal stress and the friction of emery dust.

Corundum is shown from Ceylon and from our Southern States, in the form of mineral samples, and also in grain. To the latter samples, as also to some of the Emery samples, are attached analyses showing the proportions of insoluble Corundum, of dissolved Alumina, &c., &c. Samples of Pumice Stone and of Rotten Stone are contributed by T. Van Amringe, of New York. Baeder, Adamson & Co., Philadelphia, show Rock Flint, or Quartz, and Rock Crystal Garnet, in rock, in grain and on cloth. Norris & Brother, Baltimore, exhibit India Spar. B. C. & R. A. Tilghman, Philadelphia, show Chilled Iron Shot. The Pittsburgh Crushed Steel Co. show a full line of samples of their so-called Steel Emery, and the Carborundum Co. show that material rough and finished. Mill Stone Rock is shown by W. & F. Livingston, and by Samuel Carey, both of New York. Wm. M. Kirby, Pittsburgh, shows Grindstone Rock, as do also J. Westby, Levick & Co., Sheffield, England. J. B. Hull, Stroudsburg, shows, in regular order, the materials used in rubbing down Granite and Marble. Scythe Stones rough and finished, are displayed in great variety, by P. M. Peterson & Son, Porsgrund, Norway. The Pike Manufacturing Co., of New Hampshire, also show a great variety of natural Whet Stones, &c., &c. D. A. Richardson, Helena, Montana, contributes Rough Sapphires, A. W. & C. E. Tanner, Red Bluff, Montana, some fine specimens of Garnet. Corundum is supplied to this exhibit by Ed. L. Hand & Co., Philadelphia, and by Geo. L. English & Co., New York. Among the curiosities of Abrasion are the following: Leaves of the Afeen Plant, used to clean Gourds, after the manner of Sand Paper; contributed by Bolding Bowser, Esq., U. S. Consul, Sierra Leone, Africa. Wood of Agave Polyacantha, used for Razor Strops, contributed by Wm. P. Pierce, U. S. Consul, Trinidad. Dutch Rushes, or Scouring Rush (Equisetum Hyemale), from Yorkshire, England, supplied by David Brodie, M. D., London; and Rush for same purpose, furnished by John Selwood, Stroudsburg, Pa. The epidermis of these plants is formed of Silica, and the rush is used to polish wood and metals. Shark Skin is contributed by The Tanite Co. This is to be used in same way as Emery Cloth and Sand Paper.

Samples of Carbon, or Black Diamond, and also samples of Clear or Gem Diamond, suitable for turning or dressing Emery Wheels, are shown by The Tanite Co. The evolution of Razors and Table Knives is shown in two series of samples, beginning in each case with the rough ingot or blank of steel, progressing through various stages of polish to the final bright finish.

An interesting series of photographs shows Emery Veins and Mining Processes in Westchester County, New York.

After showing how wide a range of materials and processes is covered by this compact and unique exhibit, we can close in no better way than by referring to two pictures: One of these seems to represent the tail of a comet, though what is really shown is the stream of fiery sparks streaming off from a Tanite Emery Wheel while engaged in grinding through a file. The other is a photographic reproduction of a picture in the Royal Gallery, Berlin. The photograph was contributed by Markt & Co., Hamburg, and the painting was by Gerard Ter Borch, who was born in Holland in 1617. The painting represents with much detail "The Grinder's Family," and depicts clearly the rough and primitive grinding processes then employed.

The many articles already mentioned form only a part of this exhibit; but enough has been said to show how much unexpected interest, even for the unlearned, may be found in an exhibit whose name suggests nothing but a dry, hard, technical study.

Tanite Emery Wheels

are used both for Special and General purposes, and both uses are proper. It is a true function of the Solid Emery Wheel to operate on hard steel and chilled castings. Metals too hard to be cheaply worked with steel can be cheaply worked with Emery. Thus, too, by the use of special machines, Solid Emery Wheels can be so applied as to do some of the work done by Lathe, Planer, Shaper, Milling Machine, etc. By still more specialized and automatic machines, planer knives can be bevelled and ground true, saws sharpened, calender rolls perfected, and gear wheels finished between the teeth. All these uses are proper, and so are many other uses by which skillful mechanics have contrived to do work exact and difficult.

The most proper use is that which gives the largest profit to the user. Such use consists in the application, on a most liberal scale, of ordinary shaped wheels from 8 to 18 inches diameter, on simple and moderate priced machines, for general use.

The Solid Emery Wheel is the great competitor of the File, and he who would secure the greatest profit should introduce Solid Emery Wheels as freely as Files and Vises.

The Solid Emery Wheel is a rotary file which runs a mile a minute and whose cutting points never grow dull. What the circular saw is to the hand-saw, the Solid Emery Wheel is to the File. He who equips his workshops with suitably mounted Emery Grinding Machines yokes steam engines to his files instead of men.

TABLE A.

Half-hour tests on Brass, Cast Iron, Wrought Iron and hardened Saw Steel, with Solid Emery Wheel, File, and Hammer and Cold Chisel.

Weight of Metal removed by:	Brass.		Cast Iron.		Wrought Iron.		Saw Steel.	
	lbs.	oz.	lbs.	oz.	lbs.	oz.	lbs.	oz.
Emery Wheel, . .	17		7	12	2	8	3	7
File, ...	0	8	0	5¾	0	2¾	0	1
Hammer and Cold Chisel,	1	4½	2	5½	0	10½	0	1½

In obtaining the results tabulated above, the same emery wheel was used on all the metals by the same man.

TABLE B.

Cost per lb. of removing or wearing away metals, as based upon Table A.

	Brass.	Cast Iron.	Wrought Iron.	Saw Steel.
	cents.	cents.	cents.	cents.
Emery Wheel, . .	1.8	5.8	21.2	28.9
File, ...	25.8	35.9	75.	206.4
Hammer and Cold Chisel,	10.1	5.5	19.6	137.6

See Advertisement on page 89.

EX INUTILI

TRADE

TANITE

MARK

UTILITAS

The Trade Mark of The Tanite Company is as closely associated with a *definite method* as it is with definite goods. Safe wheels, high speed, solid mountings, free cut and light touch,—these are the points for which The Tanite Company has made a quarter of a century's fight. The Tanite process (which includes the use of an organic base) is a safe one as compared with the vitrifying and artificial stone processes; and the safety of every Tanite Wheel is still further insured by its being run before shipment at double the standard speed. This speed is a mile a minute; and, if the metal being ground is kept in continuous contact with the wheel for one minute, a mile-long file of emery passes over that work in one minute. To insure continuous contact between work and wheel solid mountings are wanted, and such mountings lessen vibration and make the grinder's task easier as well as safer. Free cut and light touch lessen both the labor of the grinder and the power required to run the wheels.

Nevertheless the solid emery wheel is in disrepute and does not hold its proper position among other high class labor saving tools.—Why? Because buyers use the lowest priced and most durable wheels—because they make no discrimination in quality—because they adopt no definite method of use, and because they impute all failures to defect in the wheels.

The Tanite Company claim that *conditions of use* are as essential to success as is the intrinsic quality of the wheel, but the user gives little weight to these conditions and seems to think that any wheel ought to do under any circumstances. It is a rare thing to find wheels properly mounted and intelligently used, and rarer still to find any user who knows the cost of a wheel's product. Those who pride themselves most on their business-like method only use a few factors of the cost. They count the number of pieces ground by a given amount of wheel material, and report that a wheel of such a size has ground so many pieces, while another wheel of equal size has ground so many less. But they fail to take into account the *time*, the *man labor* or the *horse power*. When a very hard wheel and a soft one are tested against each other, the conditions should be suited to each. If this is done it will be found that the consumption of wheel material is not excessive, provided the soft wheel is used under less pressure than the hard. The reason soft wheels are considered wasteful is that the grinder applies the same excessive pressure as his hard wheel necessitates, and so wears out his wheel, tires himself, and requires more power to run his machine.

The interests of buyer and grinder are one, if they would only see it, but it is a common thing to find the grinder approve a Tanite Wheel as the best, while the buyer condemns it for its rapid wear and forces his men to use hard wheels. The apparently too rapid wear is due to the grinder's inexperience. He is offered a Tanite wheel to try —uses it just as he does a much harder one—and condemnation follows before he has time to habituate himself to its use —acquire that light touch which lessens man and horse power—which saves his strength, increases his manual dexterity, and which gives the proper economy.

We urge upon the *proprietor* this fact that grinding has been proved cheaper than filing—that wheels and grinding machines ought to be introduced as freely as files and vises, and that *his greatest economy lies* in the *greatly increased use of emery wheels for simple, general work.*

We urge on *the grinder* that that wheel is his best servant which does the work with least urging. Why should he apply a pressure of 100 lbs. if 50 lbs. will answer? Let him save his strength and so give his skill a chance.

We urge on *the foreman* that those men will work with the greatest profit whose tools and machines are of such kind and in such order that they can turn out the most goods possible, of the best quality, with the least danger, fatigue and annoyance.

We urge on *the superintendent* to supply his men with good wheels. Good wheels are those which cut freely when the metal being ground is applied with moderate pressure—which do not quickly glaze over and clog up with metal —which do not throw off chunks or burst—which do not have to be hacked and chipped to make them cut—and which can be applied to the greatest variety of work under varied conditions with the certainty that they will do fair, average work, with few stoppages for any cause.

We urge upon *the book keeper* that he shall not hastily object to our prices. Our prices for Tanite Wheels are about the highest in the world, but their value justifies the price.

These wheels are *productive tools* and their value depends on their *productive capacity*. Many other makes are in use, and such use is apparently satisfactory; superintendent, foreman, and sometimes even the grinder working by the piece agreeing that they see no use of changing to higher priced goods. Our answer is that the higher priced goods are *safer* and cause fewer accidents to life, limb and surrounding machinery; that they save time, because *they call for fewer stoppages* for break-downs and repairs; that their *productive capacity is greater*, because they grind off more metal in a given time, and because they *cut more freely*, and so require less pressure and cause *less bodily fatigue* to the grinder.

The Tanite Emery Wheel is a high class labor saving tool, but its economy depends on intelligent choice and intelligent use.

Road Making
By the Springfield Steam Rollers
at the World's Fair.

The most casual observer visiting the World's Fair could not help but wonder at the extent and fine appearance of the roadways there, comprising 120 acres or nearly 50 miles of street average width, and to many the thought would occur, by what means was this done? Of what material were these roads made? What was the nature of the ground upon which these roads are built? What length of time was required to make them? And by what class of machinery were these roads brought into such pleasing shape, solidity and uniformity?

As regards the material, by far the greater portion of the work is composed of gravel, a small portion is composed of broken stone of uniform size and hardness, and a still smaller portion is composed of broken stone and gravel mixed. The ground upon which these roadways were built was nothing but a sandy waste or bog, entirely destitute of grass and impassable to the lightest traffic. The work was commenced June 18, 1892, and finished May 7, 1893. There was however, nothing done during the months of December, January and February.

This result was mainly due to the use of six Springfield Steam Road Rollers, manufactured by the O. S. Kelly Co., Springfield, Ohio, which first rolled the sand foundation so as to enable the gravel to be put on to the proper thickness and shape, which in its turn was rolled and re-rolled until the required hardness and smoothness was attained, the heavy rollers being very effective and compacting the loose material rapidly.

A strong contrast can be imagined by picturing the ordinary method of road making, which is to gravel to a depth of 12 or 14 inches leaving it loose to be compacted by passing traffic, so that instead of having a hard, smooth surface, such as would be produced by the use of heavy steam rollers, there is a foot or so of loose gravel. If such contrasts between the rolled and un-rolled roads can be attained so quickly and effectively, the question arises, why are not steam road-rollers used on pikes or country roads? They can and should be used on every road that is made, and should be used not only on the top surface but first of all on the bottom or sub-grade as it is called. This sub-grade should be levelled off and shaped to the desired grading of the finished surface. Then, before new material is put on it, the steam road-roller should be passed backwards and forwards, and it will then be seen that what before was level is full of hollows and ridges, showing that the natural earth was not of uniform hardness, the softest places sinking beneath the roller and producing the hollows. These hollows must be filled up and the roller worked over the hard sub-grade again, making it uniform and hard. The hard or consolidated sub-grade is now ready to receive the material which is to compose the wearing surface of the road, and which should be put on in layers of say 4 inches thick and the roller be used freely on each layer. In this way, much better results can be obtained than if the roller is put on a single layer of 8 or 12 inches thickness.

The roadways on the World's Fair Ground were made by the Kimball & Cobb Stone Company, Contractors, Chicago, and the following unsolicited letter from the Superintendent in entire charge of the work is self-explanatory.

JACKSON PARK, September 28th, 1893.

THE O. S. KELLY CO.
SPRINGFIELD, OHIO.

GENTLEMEN:

We have completed the roadways on the World's Fair Ground comprising 119 46/100 acres of roadways or 49 7/10 miles of street, average width. This work was commenced June 18, 1892, and finished May 7, 1893.

We used six Springfield Steam Road-Rollers, two Pioneer Iron Works rollers and one Harrisburg roller. The greater part of the work was done with the Springfield Rollers, and we are firmly of the opinion that your machine will never be put to a more severe test than we have given it in converting what was little less than a marsh into parks and roadways of which we are justly proud. We have shown visitors that a steam road-roller is just as essential to the modern road builder as the plow is to the farmer.

Our success with your machine makes it a pleasure to send this unsolicited testimonial. We find the Springfield Rollers capable of doing the work required in every step from the soft foundation to the finished surface in a most satisfactory manner.

It is evident that the designer of the Springfield Rollers had experience and thorough knowledge of what is required to produce first class machines. They are void of complication, efficient in work, and very economical in fuel. The idea that a double engine is necessary or even more efficient is wholly wrong. The only exuse for two engines is to avoid the dead center, the inconvenience from which is entirely imaginary.

In the Springeld Roller, you have not only increased the rolling surface, but have doubled the tank capacity, coal bunkers, etc., providing for rapid and continuous work. This fact is strikingly apparent to us as we are now in our city contract finishing each day more work than we have been able to do with any other make of machine. Aside from some little expense replacing injector pipes which were allowed to freeze, the repairs have cost nothing. We do not hesitate to recommend your machine to any one desiring to purchase a steam road roller.

Yours very truly,

F. W. MYRICK, Sup't.
Kimball & Cobb Stone Co.,
Jackson Park, Chicago.

The O. S. Kelly Company received the highest medals and diplomas on their steam road roller and also on their steam asphalt roller.

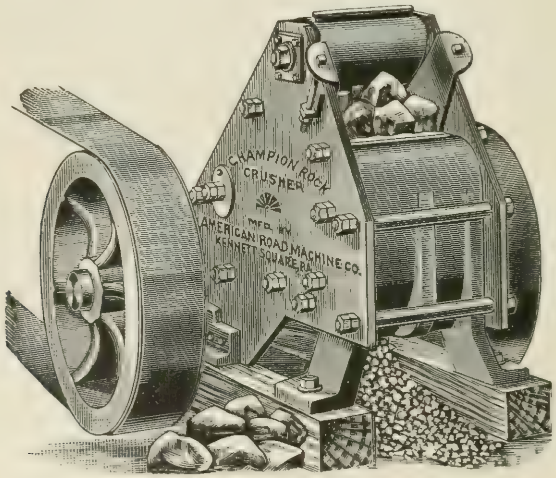
Handsome illustrated catalogue giving full description of the Springfield Rollers and much valuable information with reference to constructing and maintaining roads will be sent on application to the manufacturers, The O. S. Kelly Co., Springfield, Ohio, or Julian Scholl & Co., general agents, No. 126 Liberty St., New York, N. Y.

NOTE.—Photo Engravings of two of the machines referred to will be found among other World's Fair exhibits illustrated in this Number.

Champion Road Making Machinery.

Over one of the entrances to the Transportation Building at the World's Fair was inscribed the following quotation from that eminent historian and writer, Lord Macaulay: "Of all inventions, the alphabet and printing press alone excepted, those inventions which abridge distance have done most for the civilization of our species." An exemplification of the truth of this statement can be seen in the machines which are shown on this and the following page.

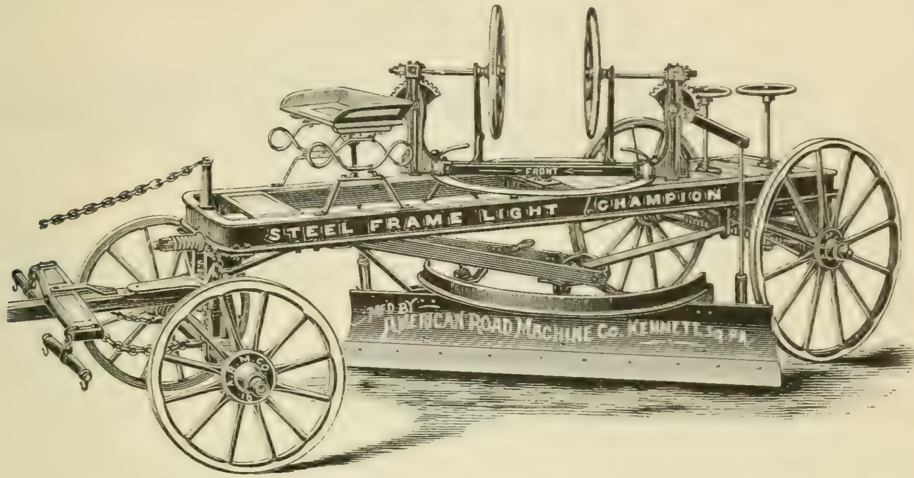
The purpose of the Champion road making appliances is to assist road makers in constructing good, smooth, durable highways over which vehicles can be drawn quickly and with the least possible consumption of power, and, as their object is a laudable one, their career has in like proportion been a successful one.



The Champion Steel Rock Crusher, as shown in the above illustration, stands admittedly without a peer.

The wide popularity of this machine with progressive road makers, contractors, engineers, quarrymen and R. R. ballast makers could only have been attained by a machine possessing real merit. The advantages of its steel construction are to be found in its light weight, great strength and durability and in the reduction of the cost of repairs to a minimum. These and many other distinctively valuable features of advantage stamp the Champion as the best crusher on the market.

The Steel Champion Road Machine.



The Steel Champion Road Machine, shown in the above illustration, for making and repairing dirt and gravel roads is so simple, so durable, so available, so easy to operate and so varied as to capacity that it cannot fail to give entire satisfaction in every respect.

The judicious use of this machine will not only result in an improved condition of public highways, but in a greatly reduced tax rate as well. The fact that it is sold and used in every State and Territory in the United States and that its sales are increasing each year, is the most substantial proof of its superiority. No town, township or county can afford to be without it.

The name Champion, as applied to road machinery, has always been identified with high grade goods, and the fact that the Champion Machines have been awarded medals for excellence of design and construction in two hemispheres, at the Paris Exposition of 1889, and the World's Columbian Exposition of 1893, will go a long way toward assuring all classes of purchasers that a standard of excellence exists in road machinery as in all other lines of manufacture, and this standard of excellence is found in Champion machines.

In addition to Rock Crushers and Road Machines, we manufacture a complete line of Road Rollers, Road Plows, Wheel and Drag Scrapers, Engines, etc. Our large illustrated catalogue descriptive of these implements will be mailed to any one on application.

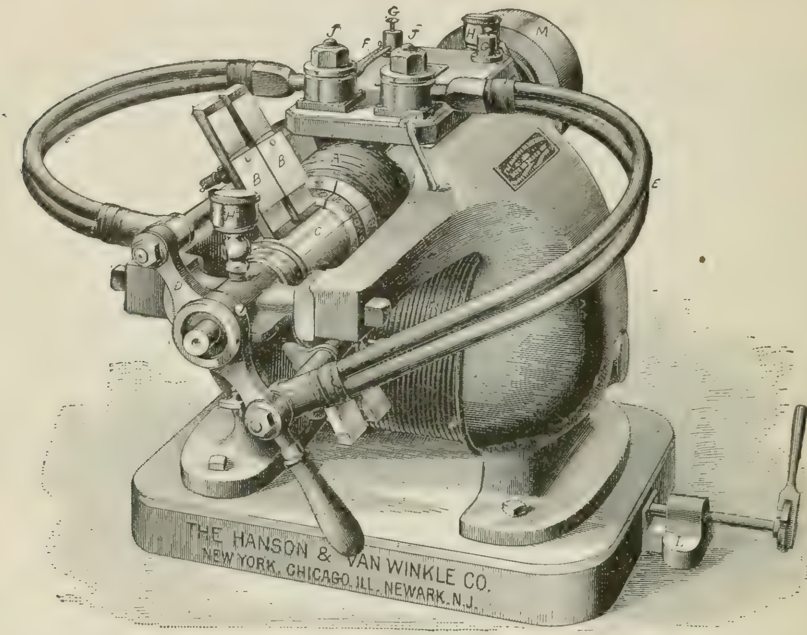
We will also be glad to mail our manual on road making, entitled "Good Roads and How to Make Them," to any one on receipt of a two-cent stamp to defray cost of mailing.

Address

American Road Machine Co.,

KENNETT SQUARE, PA.

THE HANSON & VAN WINKLE CO.



DYNAMOS.

The H. & V. W. Dynamo-Electric Machine

For NICKEL-PLATING and all other Electro deposits, Electrotyping. &c.

Has a larger sale for this purpose than all others combined.
Eight Sizes from $100 to $800. Sent on trial to responsible parties.

NICKEL.

We are the largest manufacturers in the world of pure NICKEL ANODES, pure NICKEL SALTS and standard solutions SILVER, GOLD, COPPER, &C., for plating. CYANIDE OF POTASH, all grades for Electro-Plating, Refining, Steel Hardening.

POLISHING.

TRIPOLI, ROUGE, CROCUS, VIENNA-LIME and Polishing Compositions for all purposes. POLISHING MACHINERY, BUFFS, FELT, LEATHER, PAPER AND WOOD WHEELS. Patent ACID DIPS, LYES, &C., for the economical cleaning of Castings, Etc.

LAQUERS.

CELLULOID VARNISHES (patented) and VARNISHES for Metal, Paper, Wood, &c. GUN-COTTON (soluble) and Solvents for Photographers and all other purposes.

ELECTRO-METALLURGY.

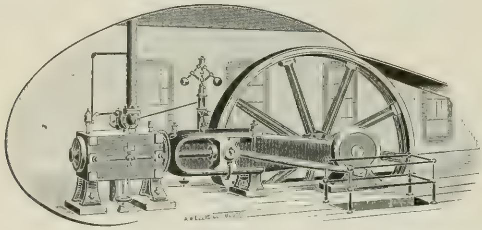
LANGBEIN'S ELECTRO-DEPOSITION OF METALS—Edition of 1894.
Over 400 pages. 150 Engravings. Price, $4.00. Postage free.
Special attention to export orders. Correspondence solicited.

THE HANSON & VAN WINKLE COMPANY,

NEWARK.	CHICAGO.	NEW YORK.
219-221 Market Street.	35-37 S. Canal Street.	81 Liberty Street.

Established 1820. Incorporated 1891.

CORLISS ENGINES



Compound, Condensing, High Pressure, 25 to 3000 H. P. for every kind of service. . . .

Heavy Duty Street Railway

AND

ELECTRIC LIGHT PLANTS A SPECIALTY.

Plans, Specifications, and Estimates for any sized Power Plants promptly furnished on application.

Address,

C. & G. COOPER CO.,

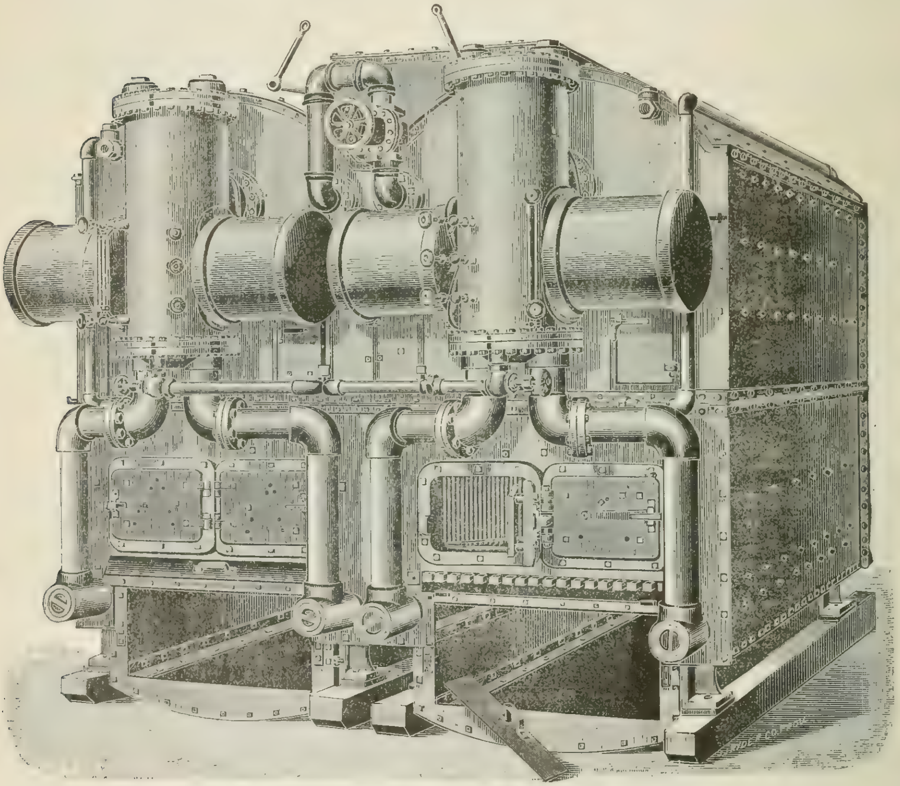
MT. VERNON, OHIO.

ALMY
WATER-TUBE BOILER CO.

MANUFACTURERS OF

Almy's Patent Sectional Water-Tube Boiler

FOR MARINE AND STATIONARY WORK,



This cut represents an 800 H. P. Boiler designed to fill the requirements necessary in a perfect Steam Generator. It occupies 8 ft. 6 in. x 9 ft. floor space and weighs 11 tons.

In the Almy Patent Sectional Water Tube Boiler is embodied the following essential features: simple in construction, a perfect circulation, large combustion chamber, a great amount of heating surface in fire-box, the most efficient method of separating the steam from the water, water in sufficient quantity to prevent excessive fluctuation, mud-drum to receive precipitation, expansion provided for in every part, access to all parts for cleaning and repairs, occupying small space, non-explosive, very light weight, but of sufficient thickness to insure strength and durability.

Write for illustrated catalogue giving full information

No. 47 Clifford Street, Cor. Eddy,

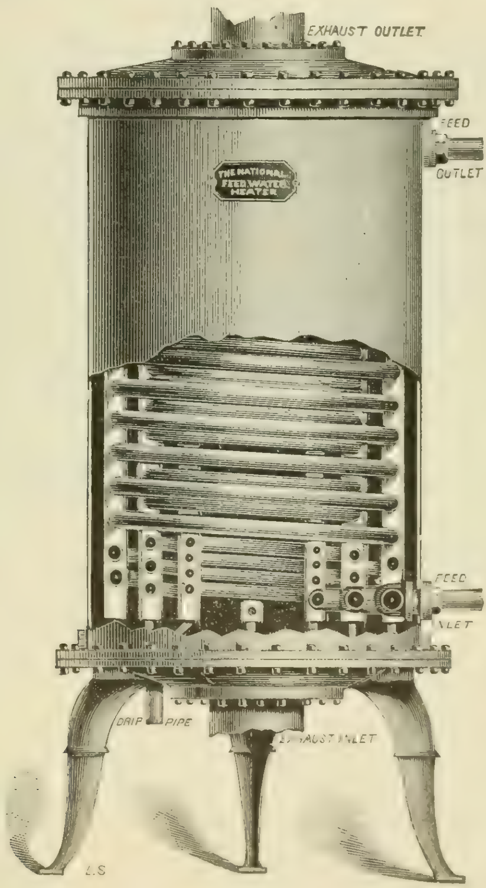
PROVIDENCE, R. I., U. S. A.

The National Feed Water Heater

A Gold Medal and Diploma

AWARDED AT

THE WORLD'S EXPOSITION, CHICAGO, 1893.



500,000 Horse Power in Daily Use.

300 Electric Stations Supplied.

This Heater is Pre-eminent in

SIMPLICITY, EFFECTIVENESS AND CHEAPNESS.

We make no Imitations and we Guarantee Satisfaction.

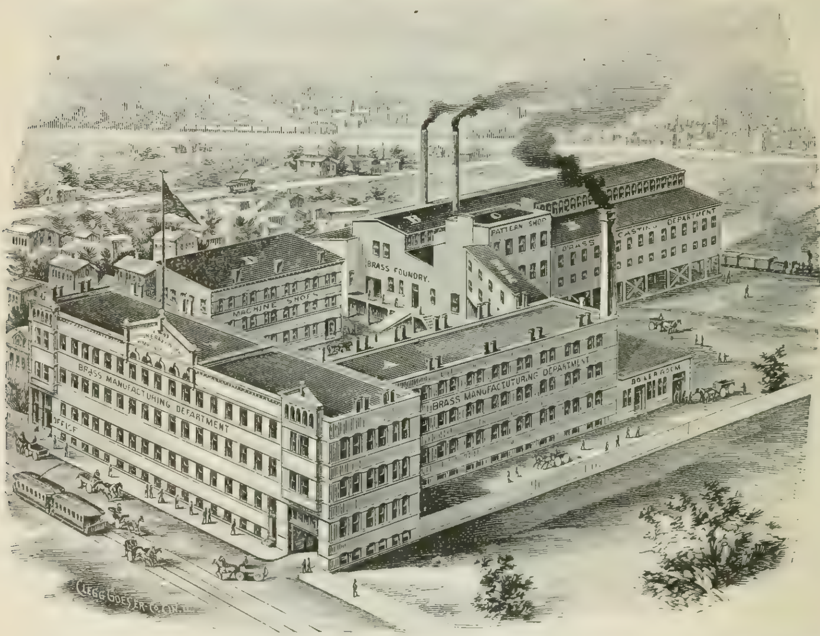
Send for our List of Customers.

THE NATIONAL PIPE BENDING CO.

47 LLOYD STREET, - NEW HAVEN, CONN.

Announcement.

We desire to call attention to ***our new location*** Nos. 225, 227, 229 & 231 Spring Grove Ave., where we have erected buildings specially adapted to the manufacture of our **Specialties** for **Engine Builders, Gas and Steam Fitters, Electric Light and Power Plants, Mills, Factories,** etc., etc.



Being equipped with all modern appliances, besides tools and machinery of our own design, we are now in a position better than ever to maintain the well-earned reputation of **POWELL'S BRASS WORK.**

STAR REGRINDING VALVES. A perfect Valve—of liberal proportions, special steam metal, and if used with ordinary care, warranted for 12 months.

STAR SIGHT-FEED LUBRICATORS. Our Up-Drop, both Single and Double Connection, which for beauty of design and finish cannot be excelled. Arms and body cast in one piece. Won't leak.

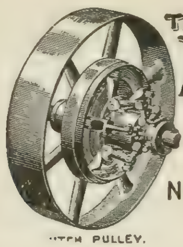
ENGINE AND DYNAMO OILERS. Our Signal and Stop-Feed Oilers are especially adapted for High Grade Engines and Dynamos. We also make Plain Glass Oilers and Crank Pin Cups.

COMPRESSION GREASE CUPS. For feeding Solid Oil or Dope to Bearings of all kinds. Brass and Plated for Engine use, and All Iron for Friction Clutches and Shafting.

Our illustrated Catalogue describing the above, and a complete line of Steam Brass Work mailed on application.

MEDAL AWARDED AT WORLD'S FAIR ON **THE WM. POWELL CO., Cincinnati, O.**

Star Regrinding Valves, Sight Feed Oilers and Lubricators.



THE MOORE & WAITE Co

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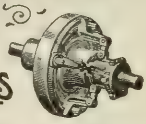
FRICTION CLUTCHES
&c.

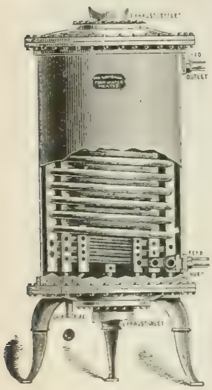
N. E. COR. 15TH & LEHIGH AVE.
PHILADELPHIA, PA



DO YOU KNOW THE VALUE OF
PURE, SOFT, TICONDEROGA GRAPHITE FOR LUBRICATING?

We shall be glad to send you a pamphlet containing scientific and practical information of interest and value. It is sent free of cost with sample of graphite.

JOS. DIXON CRUCIBLE CO. JERSEY CITY, N. J.

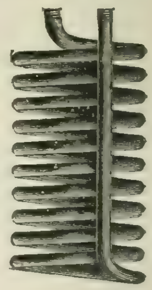


The National Feed Water Heater

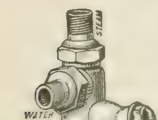
is a BRASS COIL HEATER, delivering water to the Boilers at 212° Fahrenheit. It is low in price, but of high quality. In economy and durability it has no equal.

500,000 H. P. in daily use.

Coils and Bends of Iron,
Brass, and Copper Pipe.



THE NATIONAL PIPE BENDING CO.,
47 Lloyd St., New Haven, Conn.



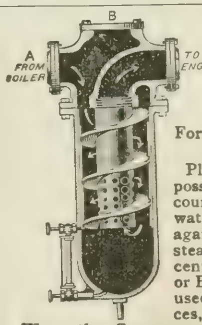
**Simple,
Reliable,
Economical,
Durable.**

The PENBERTHY Automatic Injector.

Send for Price Lists and Discounts.

Walworth Mfg. Co., 16 Oliver St., Boston.
Donegan & Swift, 11 Murray St., N. Y.

PENBERTHY INJECTOR CO., Mfrs., DETROIT, MICH



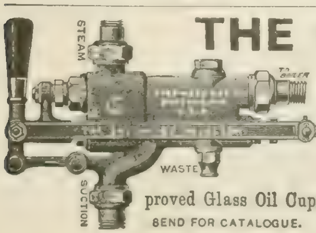
DRY STEAM.

Simpson's Centrifugal
Steam Separator.

For supplying Clean and Dry Steam to Engines, Dry-Houses, etc.

Place Separator as close to engine as possible, the steam taking a spiral course between the threads causes the water to be thrown by centrifugal force against the outer walls, while the dry steam goes through the small holes to center of pipe. Steam can enter at A or B, as convenience may require, also used in conveying steam long distances, for Steam Hammers, Dry Houses, Water Gas Generators, and for all purposes where Dry Steam is necessary.

KEYSTONE ENGINE AND MACHINE WORKS,
Fifth and Buttonwood Streets, Philadelphia.



THE SHERWOOD INJECTOR.

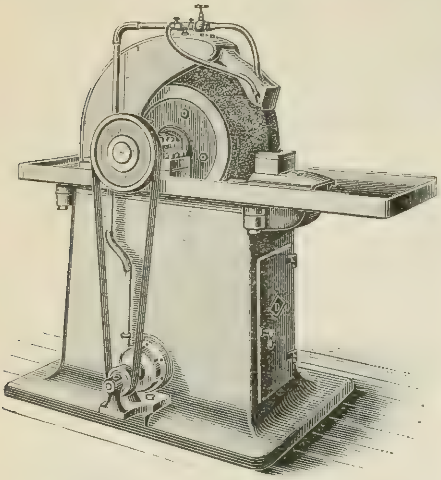
DOUBLE TUBE. OPERATED ENTIRELY BY ONE LEVER.
No Valves in Either Steam or Suction Pipe.

A HIGHER degree of efficiency secured than ever before. Will lift either hot or cold water, and is guaranteed to work satisfactorily under all pressures from 20 to 200 lbs. and to lift from 10 to 24 feet, or take supply direct from tanks or water works pressure. A HIGH GRADE MACHINE FOR HIGH DUTY.

Eagle Ejectors, Duplex Flue Scrapers, Felthousen Gauge Cocks, Improved Glass Oil Cups and Lubricators, Cylinder Oil Pumps, Compression Grease Cups, Etc.

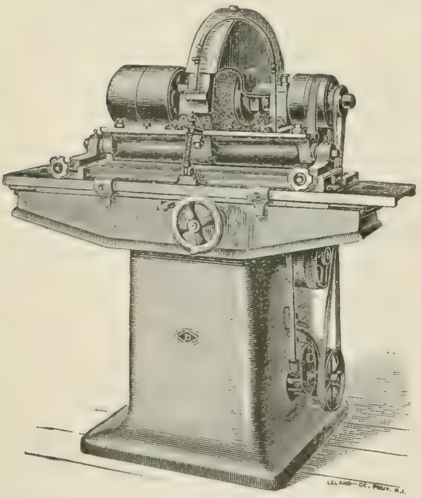
SEND FOR CATALOGUE. MENTION THIS MAGAZINE. **SHERWOOD MFG CO., BUFFALO, N.Y.**

Diamond Machine Company,



Single Wheel Tool Grinder.

No. 2, Complete with Wheel 18 x 2½ x 1¾, Counter-Shaft and Trueing Device.........$150.00
No. 3, Complete with Wheel 24 x 3½, Counter-Shaft and Trueing Device... .... 262.50
No. 4, Complete with Wheel 30 x 4, Counter-Shaft and Trueing Device...... .... 325.00
No. 5, Complete with Wheel 36 x 4, Counter-Shaft and Trueing Device.... .... 360.00

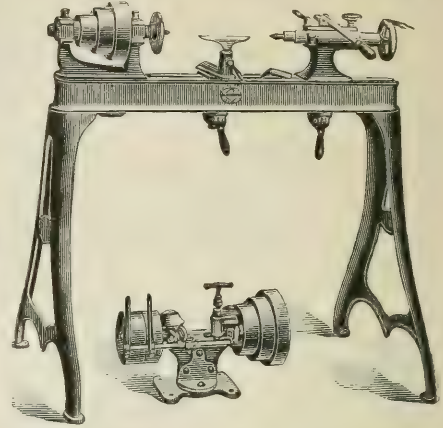


Improved Diamond Automatic Knife Grinder.

Size of Base on floor 24 x 24.
Height from floor to centre of Spindle, 38 inches.
26 inch including Wheel and with tight and loose pulley. Weight 1,000 lbs. Price.......... ...... $175.00
30 inch including Wheel and with tight and loose pulley. Weight 1,100 lbs. Price...... .... 200.00
36 inch including Wheel and with tight and loose pulley. Weight 1,200 lbs. Price 250.00
50 inch including Wheel and with tight and loose pulley. Weight 1,500 lbs. Price 300.00
60 inch including Wheel and with tight and loose pulley. Weight 2,000 lbs. Price.......... ...... 350.00
80 inch including Wheel and with tight and loose pulley. Weight 3,000 lbs. Price 450 00

Add $25.00 to list price for Automatic Pump and Connections.

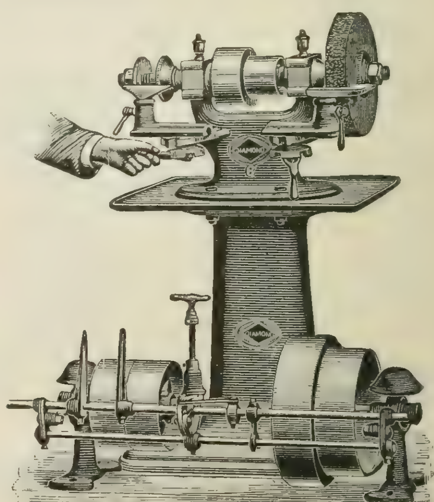
Price of Counter Shaft for this Machine, $18.00. Has tight and loose pulley 8 x 4¼. Drop of Hangers, 10 in. Single driving pulley, 13 x 4½.



Prices of Diamond Patent Lever and Screw Feed Lathes on Floor Legs.

Swing.	Bed.	Without Lever Attachment.	With Lever Attachment.	With Counter Shaft.	Extra per foot.
10 inch.	4 foot.	$60 00	$72.50	$87.50	$5.00
13 "	5 "	75.00	95 00	115.00	7.00
16 "	6 "	100.00	120.00	145.00	10.00

When ordered with short or bench legs above prices are $10.00 less.

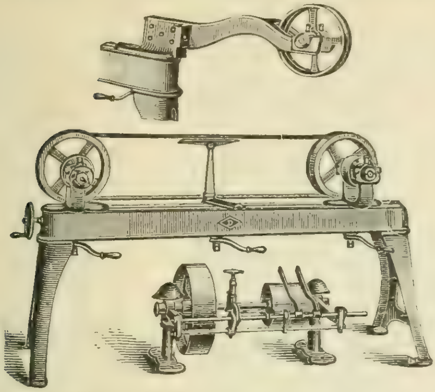


Grinding Machine No. 6.

Regular Grinding Machines. Price.

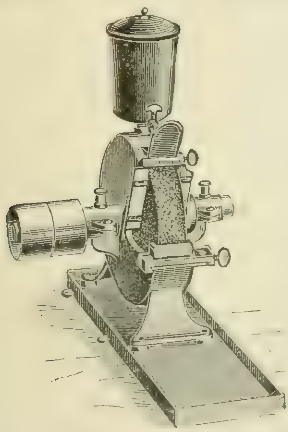
No.	Diam. Wh'ls.	Spindle.	Head.	Column.	Counter.
1	6 in.	½	$8 00	$12.00	$12.00
2	6 "	½	11 00	12.00	12.00
3	9 "	¾	17 50	12.00	12.00
4	12 "	1	28.00	17.00	15.00
5	14 "	1	35 50	15.00	17.00
6	16 "	1¼	48.00	16.50	18 00
7	20 "	1⅜	75.00	17.00	20.00
8	34 "	2	complete with counter,		200.00
9	42 "	2½	"	" "	275 00

GRINDING MACHINERY, PROVIDENCE, R. I., U. S. A.



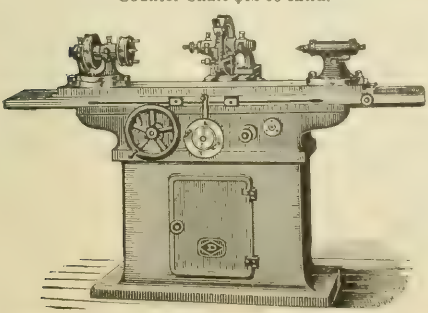
Belt Strapping Machine "D."

PRICE, Complete, as shown, with flange pulleys 14x2½ inch face, $125.00. Overhanging Arm, $25.00 extra.



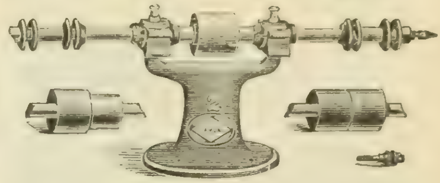
Diamond Bench Grinding Machine.

PRICE, with 10 x 1 inch Wheel, single or double Pulleys.... .... $25.00
PRICE, with 10 x 2 inch Wheel, single or double Pulleys.............. .. .. 30.00
Counter-Shaft $12 00 extra.



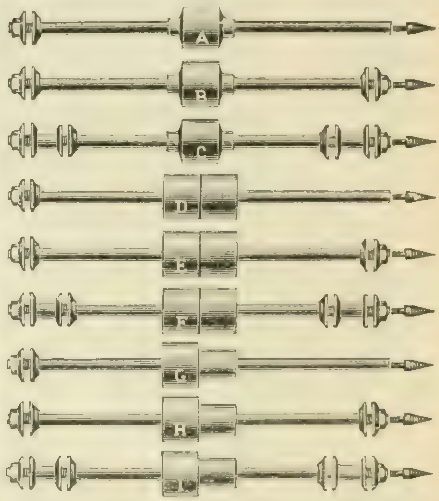
No. 3 Universal Grinding Machine.

Price of No. 1 Machine complete with Counter-Shaft and Chuck $350.00
Price of No. 2 Machine complete with Counter-Shaft, Face Plate, centre and back Rests, Wrenches, Dogs and Chuck............ ... 475.00
Price of No. 3 Machine with over-head work, Face Plates, centre and back rests, Wrenches, Dogs and Chuck..... .... 600.00
An Automatic Cross-Feed, arranged to stop at any given point, is supplied with this Machine when ordered



No. 2 Polishing or Buffing Lathe.

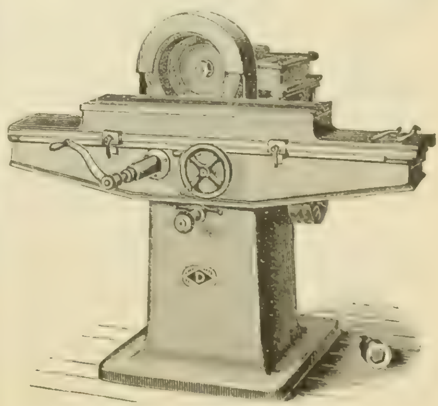
Furnished with either style of Spindle shown, at prices given.



Steel Spindles Used in Polishing Lathes.

Prices with Head shown above, including Taper Attachment.

A......$20.00	D......$22.50	G.. ...$25.00
B 22.50	E...... 25.00	H....... 27.00
C...... 25.00	F...... 27 50	I 30.00



Diamond Face Grinding Machine.

PRICE, including Wheel and with Counter-Shaft.

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No. 3—36 " " " "	1,800 lbs.	325 00
No. 4—50 " " " "	2 000 lbs.	400.00
No. 5—60 " " " "	2,500 lbs.	475.00

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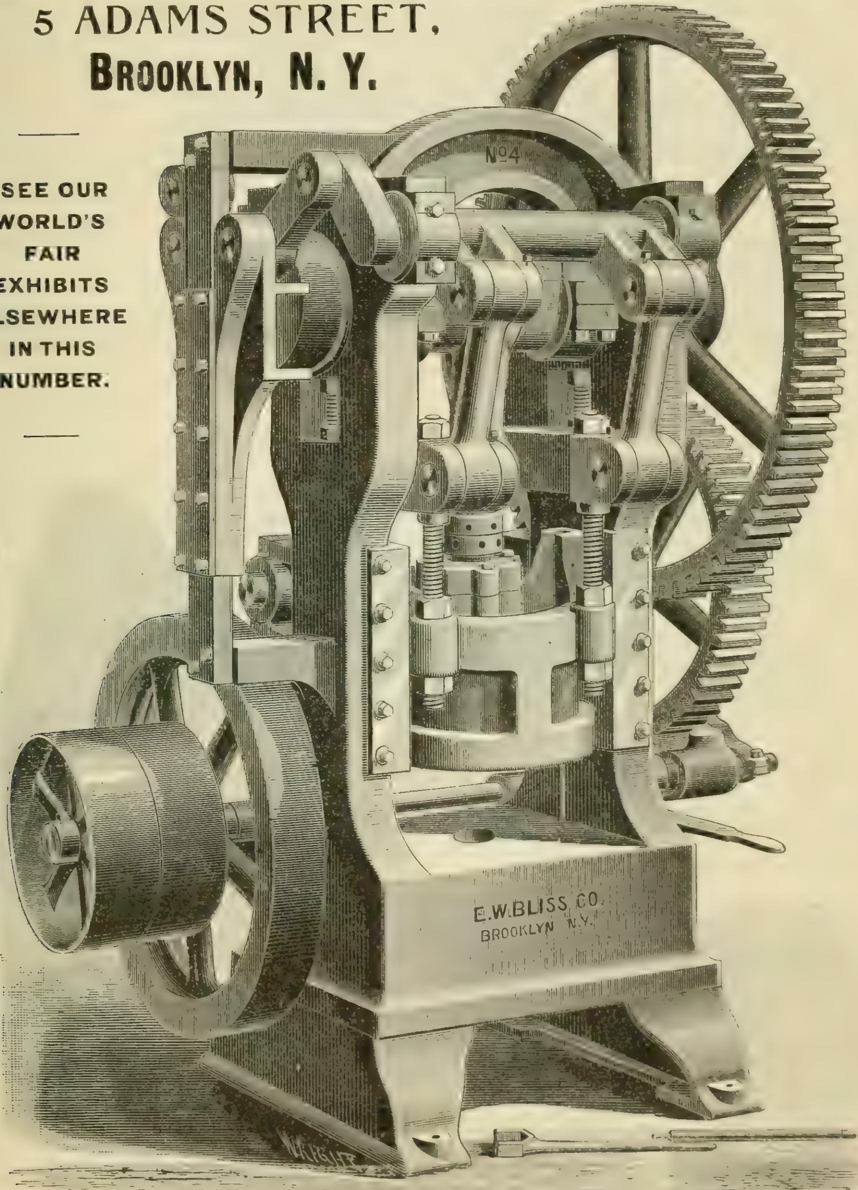

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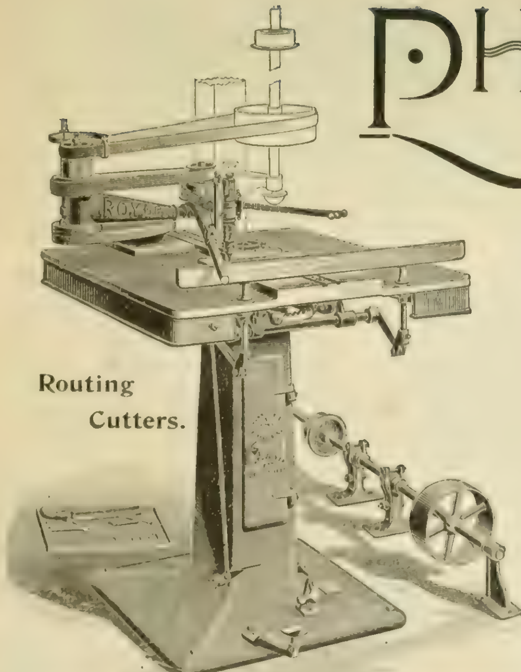
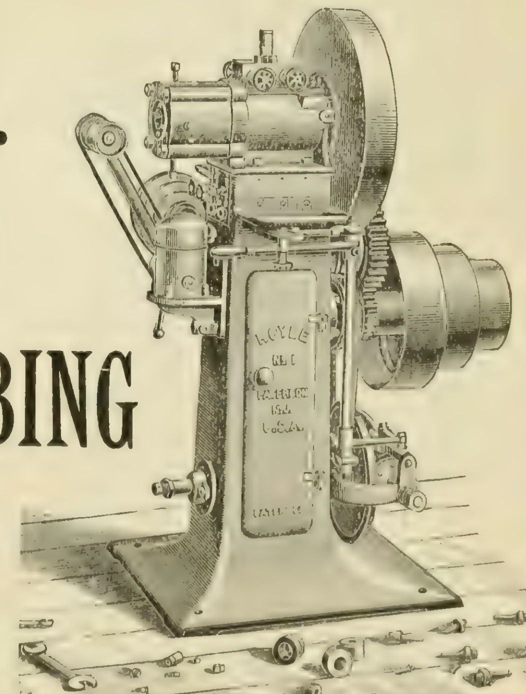
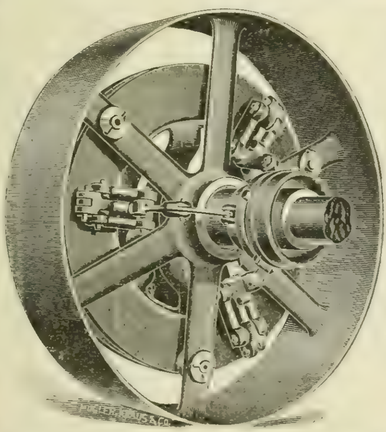
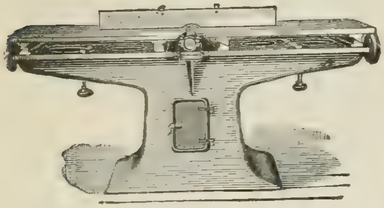
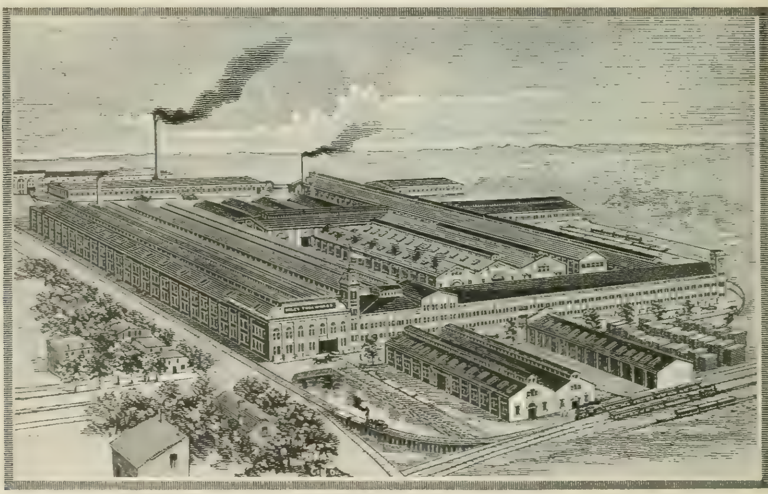


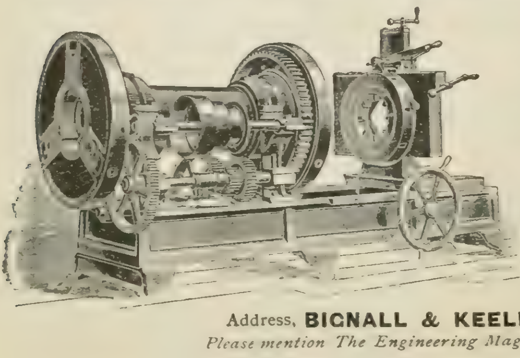
Routing Cutters.

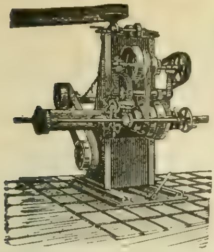












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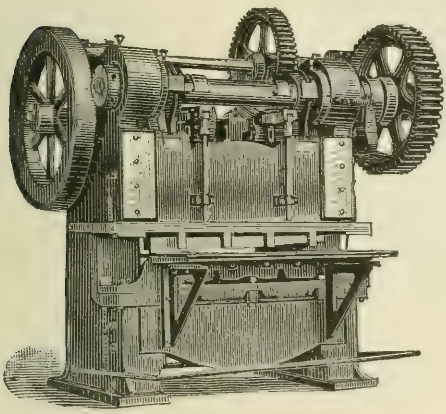

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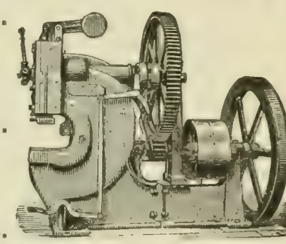

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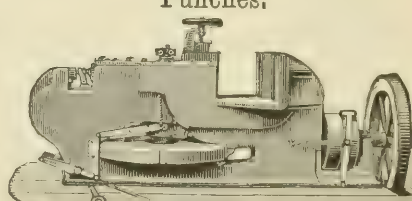

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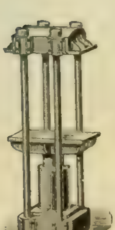

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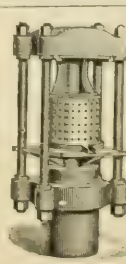

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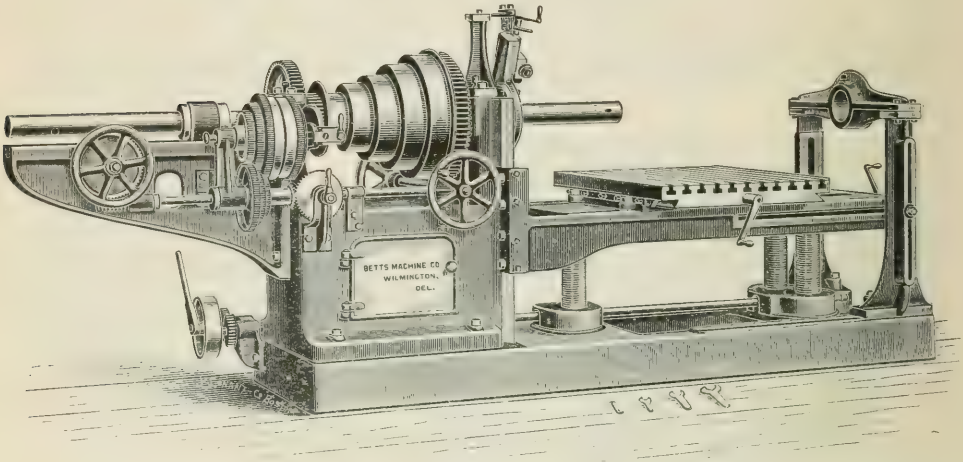

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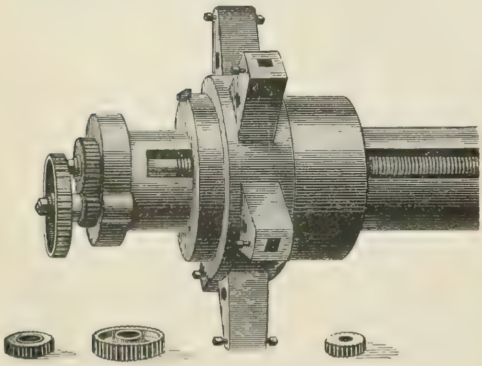

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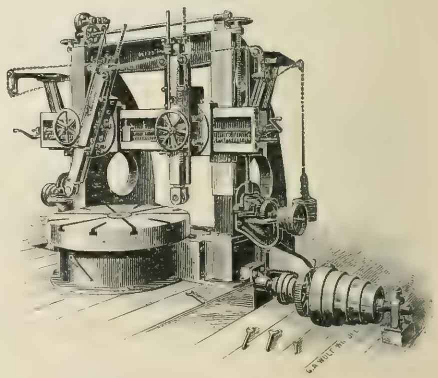

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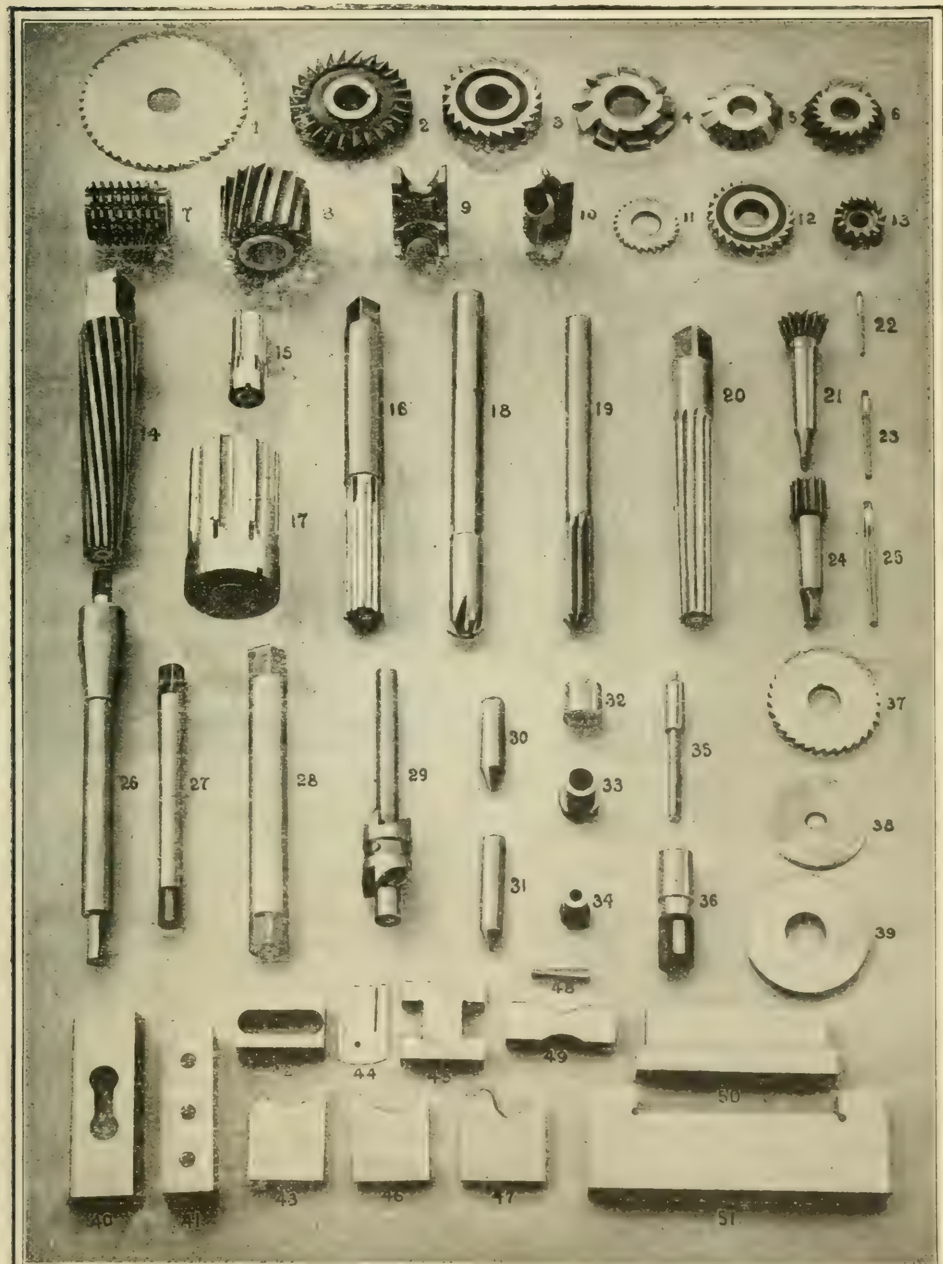

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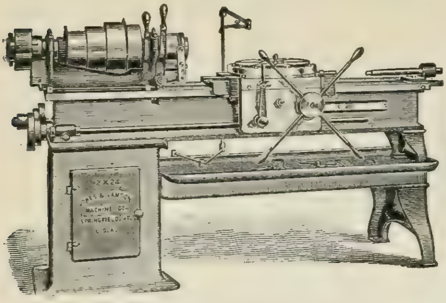

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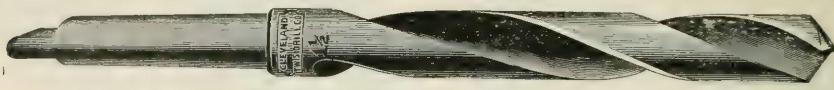

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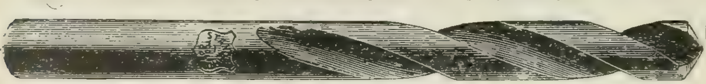

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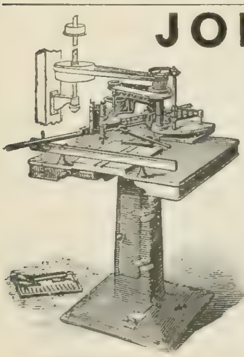

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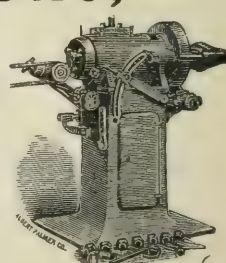

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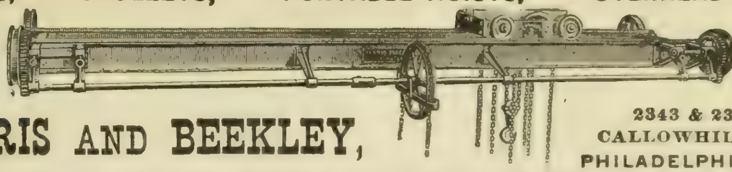

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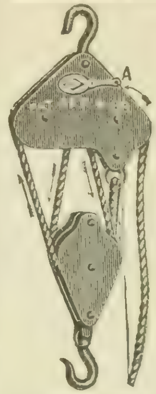

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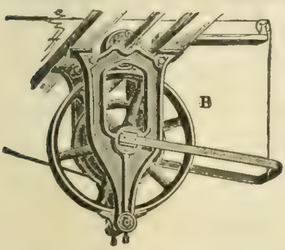

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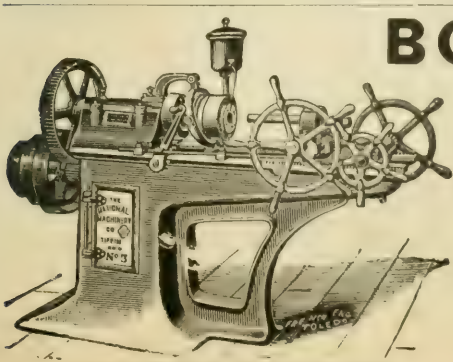

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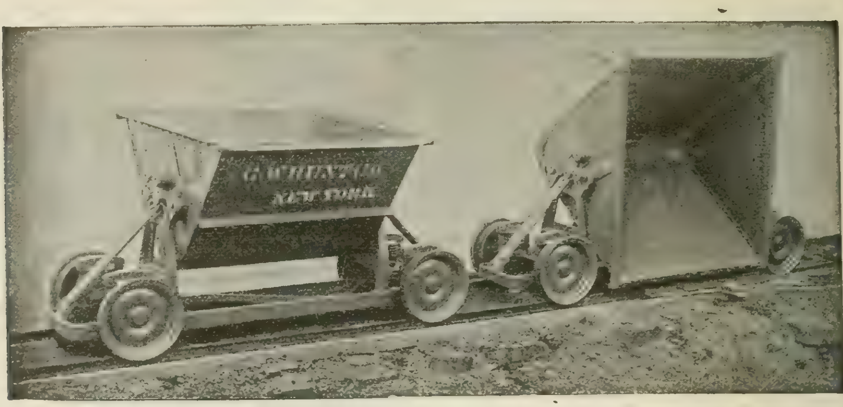

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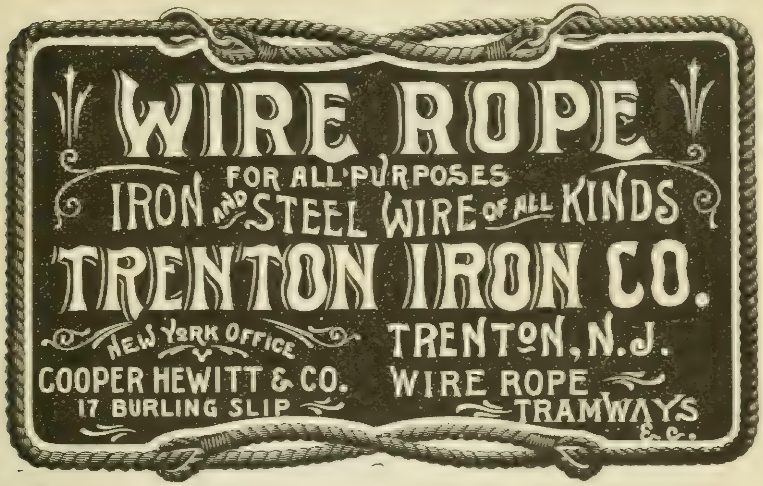
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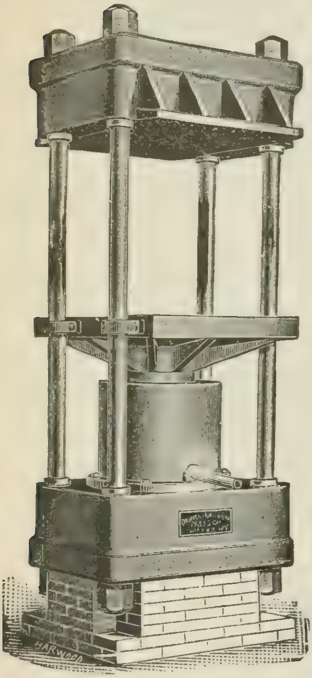

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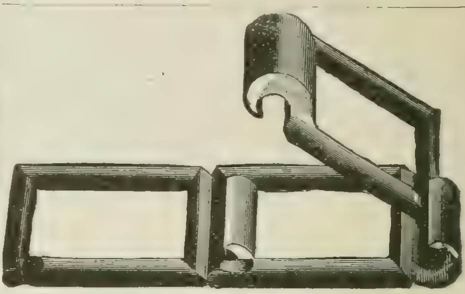

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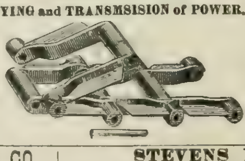

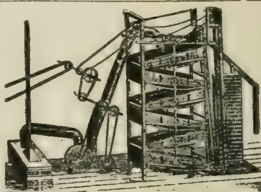

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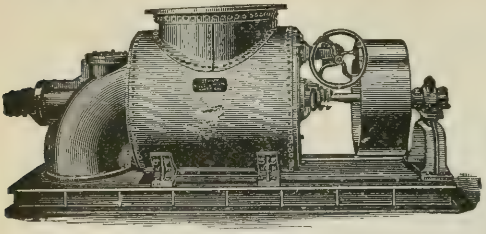

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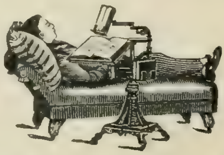
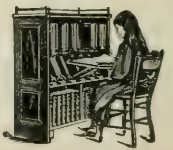

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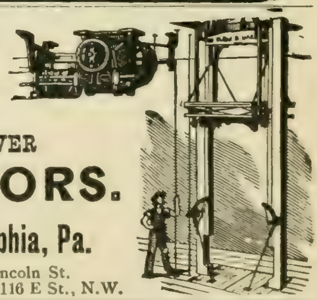

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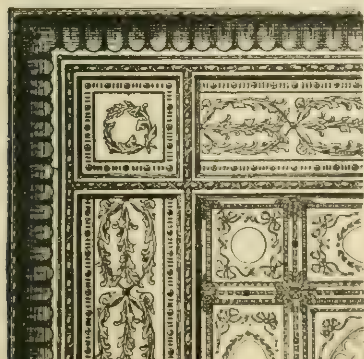

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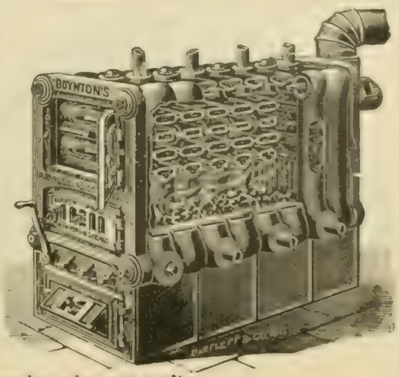

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HOW THE ANCIENTS MOVED HEAVY MASSES.

By W. F. Durfee, M. Am. Soc. M. E.

FIRST PAPER.

IT is well known to students of architecture and engineering that the ancient practitioners of these arts employed in buildings and monuments stones of much larger dimensions than it is customary to use in modern times. Travelers in the older countries gaze with wonder upon masses still remaining in the quarry, or in place in buildings,—upon wall-stones and lintels, columns and entablatures,—that far surpass in magnitude any quarried or erected in our own day. The question forces itself upon the attention of student and traveler alike: How did the builders of ancient edifices convey and elevate into position such enormous masses of stone as the ruins of their work still reveal to us?

The information on which we must rely for an answer to this question exists in no concentrated form, but is broadly scattered through the pages of history, and among the ruins of structures, and the remains of mural sculpture and paintings, whose discovery has rewarded the laborious researches of a multitude of enthusiastic archæologists during the past century. It is the purpose of the writer to collect, as fully as the limits of a magazine article will permit, the scattered evidences of the mechanical ways and means employed by the ancient architects and engineers, with a view to giving as satisfactory an answer to this constantly-recurring inquiry as is possible in the present state of our knowledge.

NOTE.—The following works have been consulted in the preparation of these papers:
The Architecture of Leon Baptista Alberti (English edition), London, 1755.
Histoire de Polybe, par MM. Thuillier et Folard, 6 volumes, Amsterdam, 1729.

The earliest means employed for lifting and removing large bodies doubtless was the application of the muscular strength of as many men as could be employed effectively,—without machinery or apparatus of any kind,—directly to the body to be moved.

This practice gradually yielded to the employment of mechanical means, though it is sometimes resorted to even at the present day. Within the memory and observation of the writer, the heavy timbers and planks used in shipbuilding were taken up an inclined plane—or "brow," as such inclined planes were then called—and placed in positions in the manner shown in the engraving on page 613, in which a party of workmen are seen ascending the "brow," carrying a timber on their shoulders. There were several objections to this primitive method of carrying heavy masses by mere muscular strength. It was by no means certain that, even if the men were of equal height, they would each carry his proper proportion of the load, for there have always been men who tried to shirk their responsibilities and thrust their burdens upon others; and even if every man was disposed to do his full duty, in moving over irregular ground the weight carried would be sure to be unequally distributed. Furthermore, there were many masses moved by the ancients whose shape made it impossible for men to handle them by mere muscular strength, although the weights might not be excessive.

M. Vitruvii Pollionis de Architectura, Venetiis, 1567.
Agricola, de re Metallica, Basileæ, 1556.
Professional Papers of the Royal Engineers, Vol. X, London, 1849.
L'Art de Batir les Vaisseaux, Amsterdam, 1719.
The History of the Arts and Sciences, by Rollin, London, 1768.
Origin of Laws, Arts, and Sciences, by Gouguet, 3 volumes, Edinburgh, 1761.
A Thousand Miles up the Nile, by Amelia B. Edwards, London, 1890.
History of Ancient Egypt, by George Rawlinson, M. A., 2 volumes, Philadelphia, 1882.
The Discovery of Jerusalem, by Captains Wilson and Warren, R. E., London, 1871.
Rawlinson's Ancient Monarchies.
Wilkinson's Manners and Customs of the Ancient Egyptians, 3 volumes.
Rawlinson's Herodotus.
Discoveries in the Ruins of Nineveh and Babylon, by Austin H. Layard, London, 1853.
Egyptian Obelisks, by Lieutenant-Commander Henry H. Gorringe.
Pyramids and Temples of Gizeh, by W. M. Flinders Petrie.
Life and Work at the Great Pyramid, 3 volumes, by C. Piazzi Smith.
Edinburgh Philosophical Transactions, Vol. IX, 1821.
Edinburgh Philosophical Transactions, Vol. IV.
Ewbanks's Hydraulics, New York, 1850.
Egypt, Descriptive, Historical, and Picturesque, by G. Ebers.
Tanis and Noucratis, by W. M. Flinders Petrie.
Anthropological Journal, 1883.
Operations at the Pyramids, by Colonel Howard Vyse, 1840.
The Land of the Pharaohs, by Rev. Samuel Manning, LL.D., London.
Le Diverse et Artificiose Machine del Capitano Augustino Ramelli, 1588.

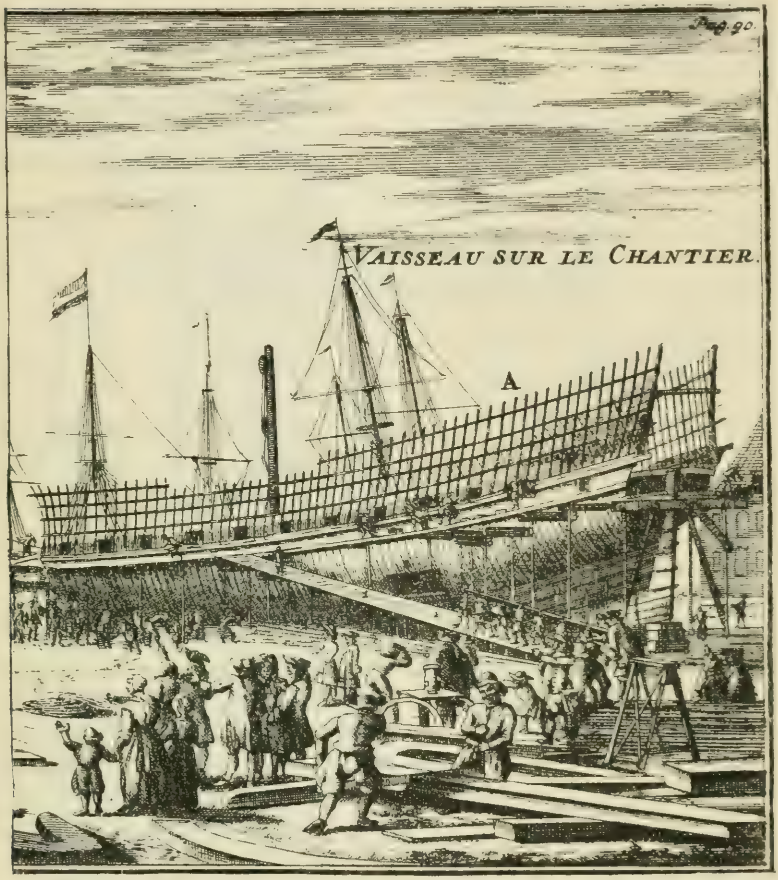


FIG. 1.—CARRYING TIMBER ON MEN'S SHOULDERS.
[From "L'Art de Batir les Vaisseaux," Amsterdam, 1719.]

For the preservation of the means of overcoming these objections to the early manual method of mere lifting and lugging we are indebted to the Chinese. In 1846 certain buildings for the Ordnance Department at Hong Kong were erected by Chinese workmen under the superintendence of Major Edward Aldrich, R. E., who stated that the men were "very ignorant of the value of machinery and averse to its use"; and that "all land transport for the ordnance building for every description of article has been performed solely by manual labor"; and that "462 granite columns," "each weighing 38½ cwt.," were carried "from the quarry to the building," a distance of "about half a mile," by "the united

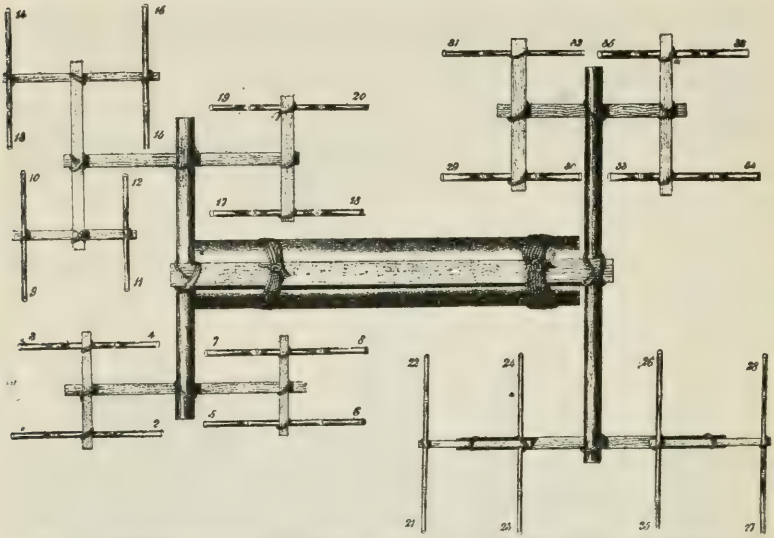


FIG. 2—CHINESE DEVICE FOR EQUALIZING LOAD IN THE CARRYING OF HEAVY MASSES.

power of 36 men" applied as shown in Figures 2, 3, and 4. Very little explanation is necessary to the understanding of these engravings. Figure 2 is a plan of the combination of timber and bamboo to which the column was secured by "lashings," and the peculiar "swingletree" articulation of the several parts of this very ingenious and simple mechanism was such that each man located at the numbered ends of the bamboo rods was obliged to carry just as much as, and no more than, any other man in the party. No man could possibly avoid doing his allotted share of the work, whatever his stature or the irregularities of the ground to be traversed. In Figure 3 the men are seen carrying one of the columns; "in moving they all kept step, occasionally changing step, at the same time removing the weight from one shoulder to the other."

Major Aldrich thus comments upon this very simple and effective operation: "At the present day the attention of the world is so engrossed by scientific improvements that the power of manual labor in its simple and single state is lost sight of, and to an extent that we now look upon the Egyptian and Grecian monuments of art with amazement. Our busy thoughts are puzzled to describe the mode adopted for their erection, and we almost leave the consideration with the impression that their erection without the application of mechanical powers was impossible. The means, how-

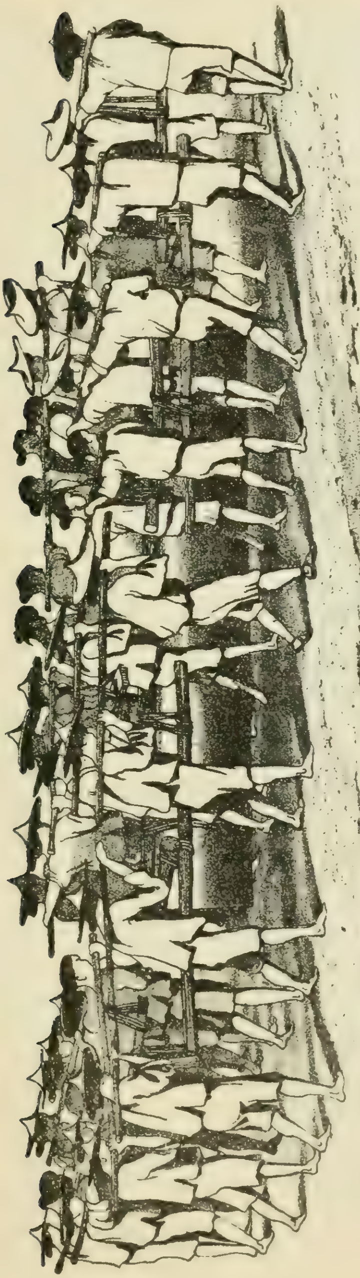


FIG. 3.—THE CHINESE DEVICE APPLIED IN CARRYING A COLUMN.

ever, used in the transport of heavy weights by the Chinese at this station, on the ordnance buildings, recalls our attention to the power of manual labor in its simple state, to the united strength of men, and to the gigantic power derived by such unity, — pointing clearly to the feasibility, by such simple means, of undertaking even a building in rivalry of the Temple of the Sun at Heliopolis."

The sled seems to have been a favorite vehicle in ancient Egypt and Assyria for the conveyance of heavy loads, and there is no evidence offered by wall-paintings or sculptures that wagons were known in the early days of these countries, though two-wheeled carts and chariots were common, the last being a most important item in the equipment of an army. According to Diodorus Siculus, the chariots of Sesostris (2600 B. C.) numbered 27,000; and Joshua (1450 B. C.) tells us that the Canaanites had "chariots of iron." Later Sisera had "900 chariots of iron." The use of iron for chariots is evidence that it could have been used for the cutting of stone. Solomon (1000 B. C.) obtained a

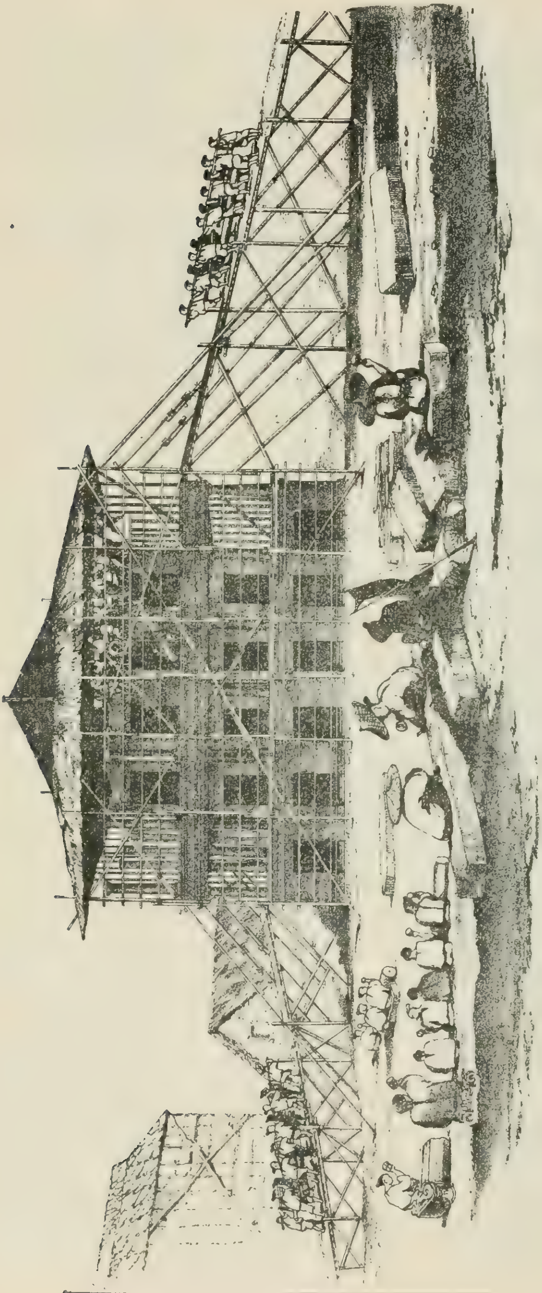


FIG. 4—THE CHINESE DEVICE APPLIED IN CARRYING LOADS UP AN INCLINED PLANE.

chariot from Egypt at a cost of "600 shekels of silver" (about $300) which was probably used as a model for the fourteen hundred which he placed in "the chariot cities" of Judea. But while the ancient Egyptians and Assyrians were well acquainted with the use of wheels they do not appear to have employed them in transporting building stones or large masses of any kind. The sled seems to have been the vehicle chosen for such purposes by each of these nations, being drawn sometimes by oxen, but not infrequently by large numbers of men.

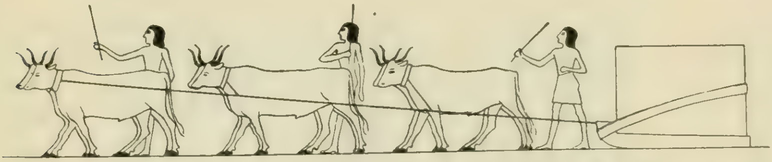


FIG. 5.— ANCIENT USE OF THE SLED, SHOWN IN A PAINTING AT EL MAUSARA.

A painting at El Mausara (Figure 5) shows a sled, of which we find a survival in the "stone-boat" or "drag" of our day, laden with a large mass of stone, and drawn by six oxen. In Figure 6 we have a representation of a funeral-barge resting upon a sled drawn by oxen. Figure 7 illustrates the transportation of a colossus from a tomb at El Bersheh (2600 B. C.), upon a sled drawn by men. Great care seems to have been taken to secure the colossus to the sled by means of ropes made "taut" by twisting them by sticks. Where the ropes cross finished parts of the sitting figure and the chair soft material is interposed to prevent the ropes from abrading the stone.

The ancient Assyrians seem to have improved upon the Egyptian method of employing the sled. Two sculptures discovered by Layard at Nineveh (Figures 8 and 9) show the operation of transporting by means of a sled a human-headed bull. In Figure 8 the bull is represented as lying on his side, but in Figure 9 he is standing upright, his legs being relieved from the danger arising from sudden shocks during transit by blocking beneath the body, which removed a large part of its weight from the legs. In each engraving it will be noted that rollers were used beneath the runners of the sled. These rendered the use of lubrication unnecessary, so that a man with a grease-pot was not needed in front of the sled, as in the Egyptian practice. A long lever is used behind the sleds to assist in putting them in motion or to raise their rear ends out of some depression in the road. In Figure 8 the king is seen in a canopied chariot supervising the operation, and in the left foreground are a couple of capstans; ropes, rollers, and levers are provided in abundance; the "gang-boss" occupies his commanding position; a party of men seem to be removing stones and other rubbish from the route of the sled; and everything indicates careful preparation for the work in hand. Sleds are shown by Egyptian tomb-paintings to have been used to convey live wild animals in cages.

The Egyptians excelled all the nations of antiquity in quarrying large masses of stone and transporting them over long distances. In the plain of Quoreren there are two colossi of Ameno-

FIG. 6—AN EGYPTIAN FUNERAL BARGE RESTING UPON A SLED.

phis III (about 1400 B. C.) of a single block each, (one of these being the vocal Memnon) forty-seven feet in height, containing about 11,500 cubic feet (about 1000 tons) of a stone not known within several days' journey of the place. Herodotus states that 2000 men were occupied three years in bringing from Elephantine to Sais by order of Amasis (569 to 525 B. C.) a single block of stone hollowed out for use as a small temple or sanctuary. This mass was $31\frac{1}{2}$x22x12 feet externally, and $28\frac{1}{4}$x18x$7\frac{1}{2}$ internally, and weighed about 400 tons. The monolythic temple which Herodotus says was transported from Elephantine to Birto in the Nile delta was a sixty-feet cube externally; if we suppose its walls to have been six feet in thickness it must have weighed upwards of 5000 tons.

The transportation of large masses of stone by water-craft was a common practice in ancient times, in both Assyria and Egypt. A bas-relief of Koyunjik* (2000 B. C.) il-

*George Rawlinson's "Five Great Monarchies," Vol. I, p. 421.

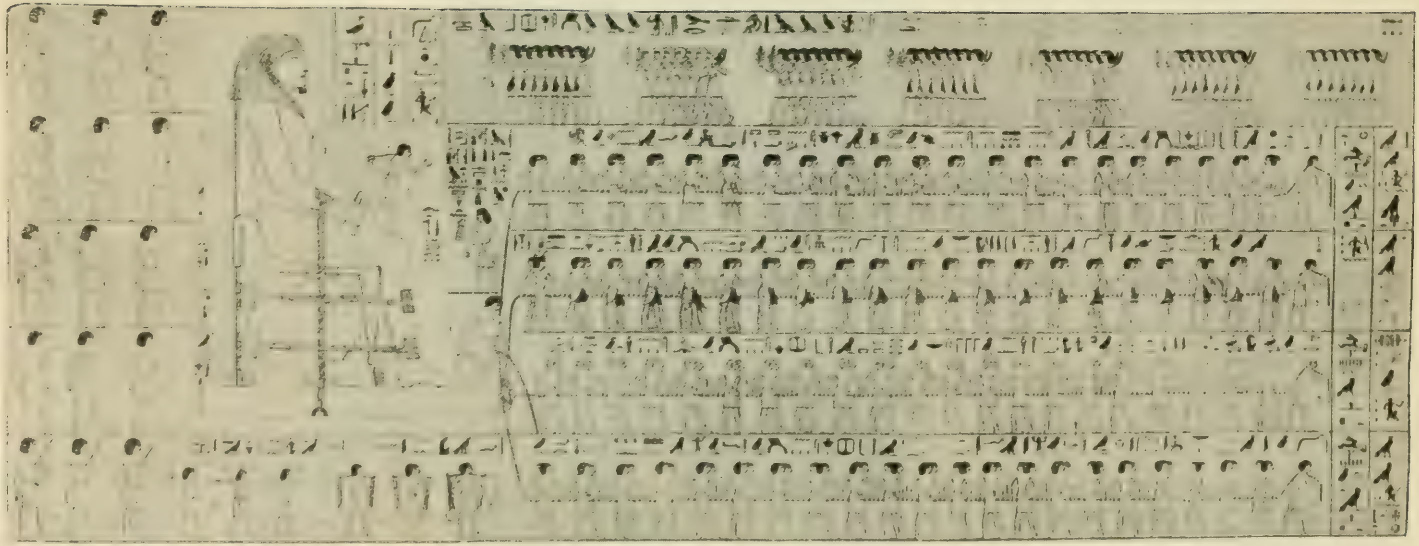


FIG. 7—TRANSPORTATION OF A COLOSSUS (FROM A TOMB AT EL BERSHEH).

[The sled is drawn by 172 men, divided into four companies of 43 each. At the top of the picture is shown a relief party, and at the bottom three men carrying a liquid, by means of yokes. In front of the sled a man is pouring a lubricant upon the ground. Standing on the knee of the Colossus a "gang-boss" appears to be "marking time" by clapping his hands.]

lustrates the conveyance of stones by means of a raft or pontoon supported by the inflated skins of animals. It is absolutely certain that all the limestone used in the pyramids of Gizeh (3200 to 960 B. C.) was moved in part by water, as the quarries from which it was obtained are located east of the Nile. Pliny tells us that obelisks were transported down rivers upon two flat-bottomed boats which were lashed together side by side, and admitted into a basin cut at right angles to the bank of the river beneath the obelisk. These boats were loaded with a quantity of ballast exceeding in weight that of the block to be transported, and when they were secured in proper position below the stone the ballast was thrown out, and the boats rising, as they were lightened, bore

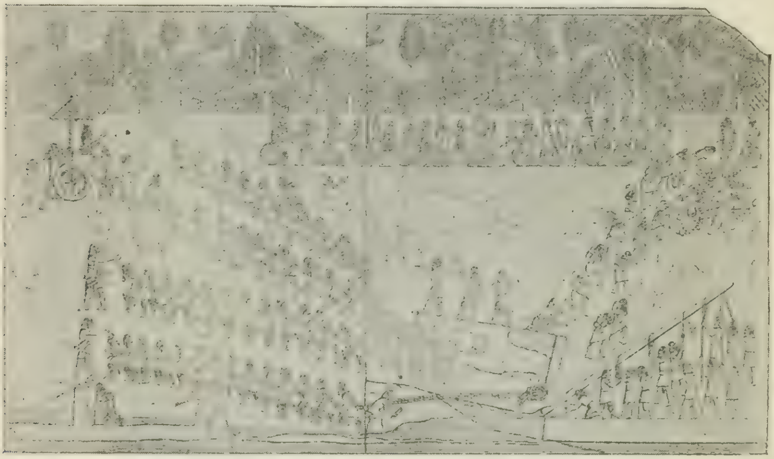


FIG. 8—REMOVAL OF A COLOSSAL BULL AT NINEVEH BY MEANS OF A SLED.
[From a sculpture discovered by Austen H. Layard.]

away the obelisk instead of their previous burden. Pliny credits one Phœnise with the invention of this method, but fails to say at what period he lived.

The architects and engineers of Asia Minor deserve credit for the invention of some highly-original methods of transporting rough columns and large rectangular blocks. Chersiphron, the architect of the great temple of Diana at Ephesus (600 to 560 B. C.), —which was accounted among the seven wonders of the world,— included in its design 127 columns of marble sixty feet high and about seven feet in diameter. Vitruvius states that Chersiphron, observing that the roads were not firm enough to bear the weight of such vast columns upon carriages whose wheels would sink into the ground, contrived a frame as shown on the right of Figure 10. This consisted of four timbers enclosing the rough-hewn column. At the center of each end of the column he fixed a large iron pin, barbed at the end within the stone, and well secured with lead. The projecting ends of these pins passed through iron bearings in the end cross-pieces of the frame. Poles of oak were secured to two of the corners of the frame by iron hooks and strong iron rings. Oxen were attached to these poles and as they moved forward the column turned and was drawn with no great difficulty to Ephesus, a distance of eight miles.

Following out the idea of Chersiphron, his son Metagenes, who

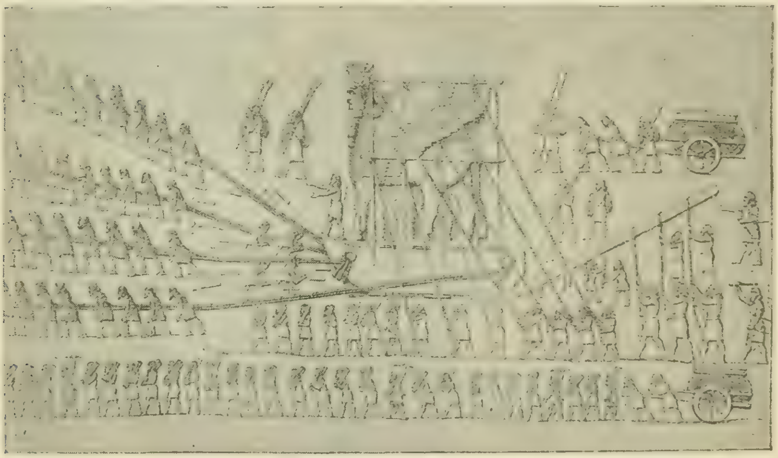


FIG. 9—ASSYRIANS TRANSPORTING A HUMAN-HEADED BULL.
[Partially restored from a bas-relief at Kouyunjik.]

succeeded him as architect of the temple, contrived the method illustrated on the left of Figure 10 for conveying architraves, some of which were thirty feet in length. He made strong and broad wheels about twelve feet in diameter, in the center of which he fixed the architrave, having large iron pins in the middle of each end; these pins turned in bearings in the end cross-pieces of the enclosing frame, in the same way as the column, and oxen were attached to poles to draw the stone as before described.

In the time of Vitruvius (about 30 B. C.) one Paconius undertook to bring from the mines the base (twelve feet high, eight feet broad, and six feet thick) for a colossal statue of Apollo. His

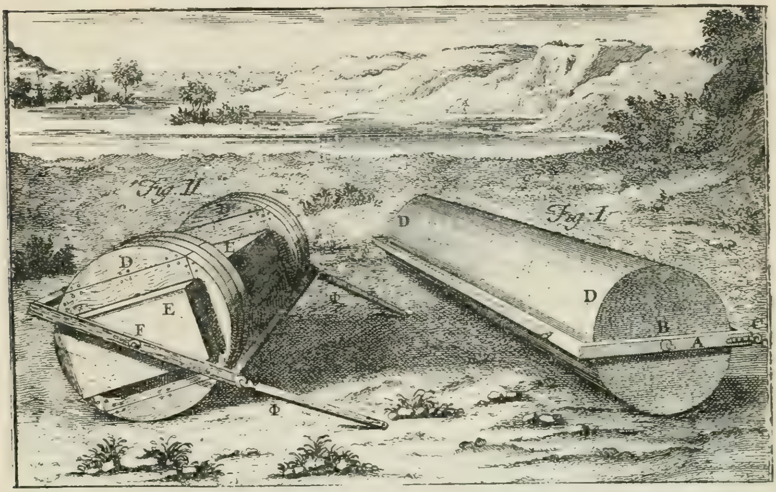


FIG. 10—CHERSIPHRON'S DEVICE FOR CONVEYING COLUMNS TO THE TEMPLE OF DIANA AT EPHESUS.
[Shown in the section of the picture to the right. On the left is shown a modification of this method, invented by Metagenes.]

machine, though somewhat similar to that of Metagenes, was of a different construction. It consisted of two strong wheels (Figure 11) fifteen feet in diameter, into which the ends of the stone were fixed. Through the rim of these wheels round spokes were driven. Around these spokes a cable was wound, and to this the oxen were attached for setting the machine in motion. But Vitruvius

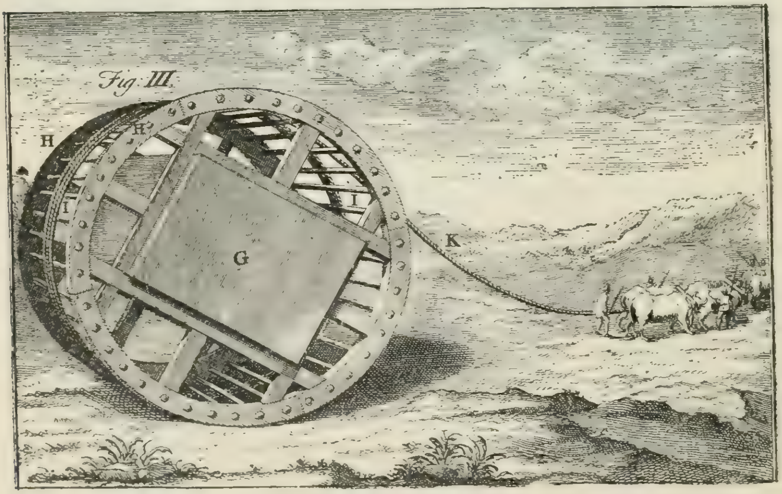


FIG. 11—DEVICE OF PACONIUS FOR TRANSPORTING THE BASE OF A COLOSSAL STATUE OF APOLLO.

says that as the cable never drew from any fixed or central point, the machine continually turned either to the right or to the left, and could not be made to answer its intended purpose. M. Perrault expresses surprise at this and suggests that, by adding another cable to equalize the draft, it might have been made a better machine than that of Metagenes.

One of the methods employed by the ancient engineers for moving large masses is well illustrated by the means taken to move the vast towers of timber used in the attack of fortified places.

Such towers were called Heleopoli, or city-takers, and were said to have been invented by Demetrius Poliorcetes (Demetrius the Besieger) and first used by him at the siege of Rhodes (305 B. C.) Figure 12* illustrates the general constructive features of such towers, which were always constructed beyond the range of the offensive powers of the besieged, and then filled with armed men, and drawn towards the intended point of attack in the way shown in the engraving,—the men operating the capstans being protected from injury by the tower itself. As soon as the tower reached a point sufficiently near the invested place, the two-leaved drawbridge (seen on the right of the tower) was suddenly lowered upon its wall, and a storming party rushed from the tower over this bridge and took forcible possession of the immediate vicinity of the point of attack ; reinforcements were rapidly pressed forward by means of the tower and its bridge, and in the meantime (such times were always "mean" to the vanquished) the defenders of the place were constantly annoyed by arrows, stones, and other missiles discharged from the top of the tower, which was always made high enough to command the point attacked.

Some of these towers were over a hundred feet in height. Anna Comnena (born A. D. 1083), in describing in her "Alexiad" a tower used at the siege of the city of Duras, says : "It was square and of such prodigious height that it exceeded the towers of the city. It was intended to descend from it upon the walls by its bridges, and to fall upon those that defended them with an irresistible impetuosity. This tower was terrible to see even afar off, as it advanced like a giant whose rapid strides nothing could resist. It

* From the Chevalier Folard's commentary on Polybius' "History of the Art of War." [Amsterdam, 1729.] Polybius the historian, soldier, traveler, lawgiver, and diplomatist, was born about the year 204 B. C. and died when eighty-two years of age. His history is one of the most valuable of ancient writings that we have inherited. The work originally consisted of forty books, of which only five have been preserved entire ; many are entirely lost and of others we have but fragments.

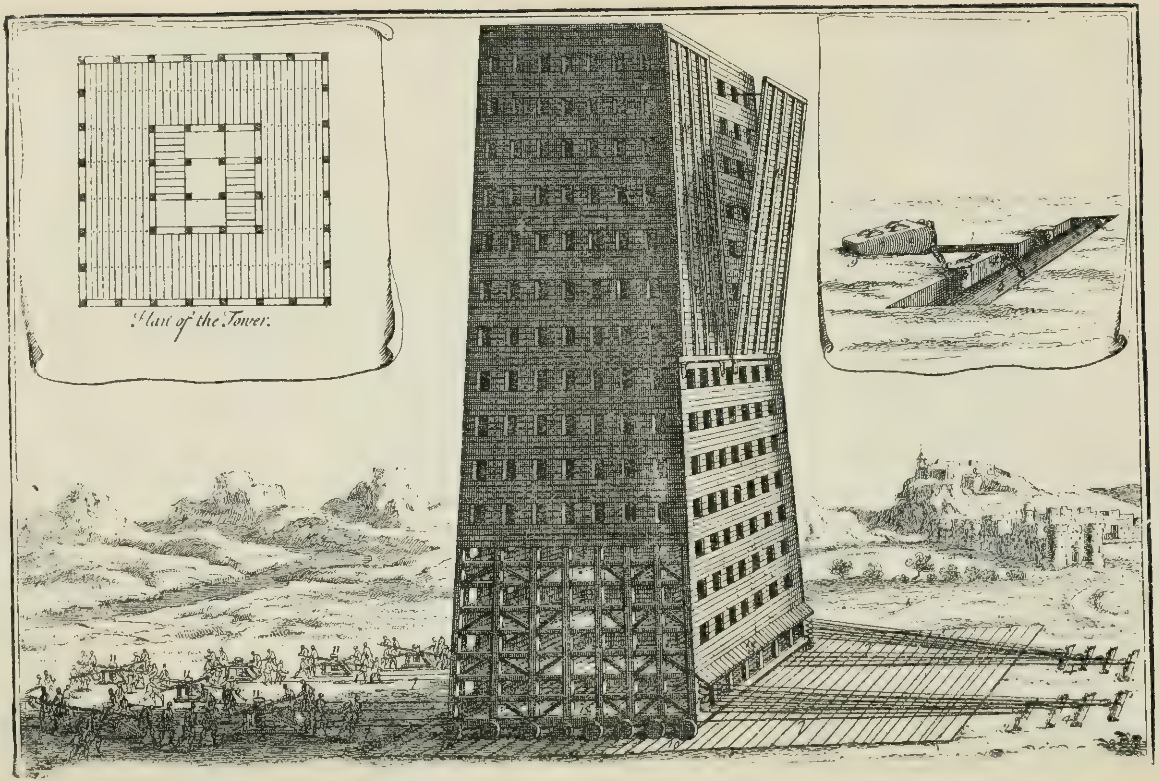


FIG. 12—PLAN OF CONSTRUCTION AND METHOD OF REMOVAL OF ANCIENT TOWER USED IN ATTACKING FORTIFIED PLACES,

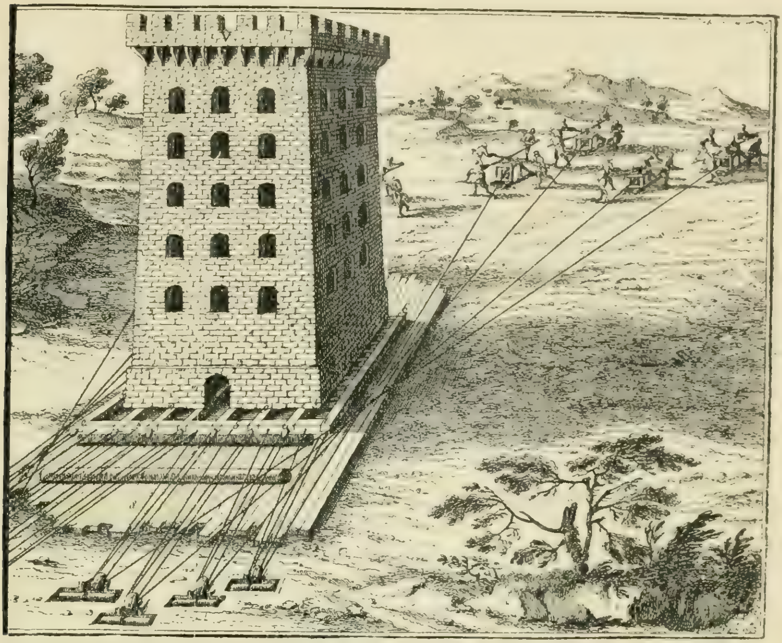


FIG. 13—REMOVAL OF A MASONRY TOWER BY A BOLOGNA ARCHITECT IN THE FIFTEENTH CENTURY.

was pierced by a great number of openings through which men shot incessantly. The highest floor was full of men with swords in their hands which never rest from slaughter."

The removal of the Seringapatam obelisk (about 1815) from the quarry to its intended site, a distance of two miles, by native Hindoo workmen unaided "by any European," is thus described by Colonel Wilkes : "The carriage on which the shaft of the obelisk was conveyed from the quarry was supported by eight wheels or rollers, four without, and as many within, the cheeks of the machine. . . . It required about 600 men to drag the obelisk, and the operation was extremely tedious."

In Figure 13 is shown the method of moving a tower of masonry adopted by an architect of Bologna in the fifteenth century.* It will be noted that the operation was similar to that of moving the Heleopolis of Demetrius, but in this case large cylindrical rollers were used instead of wheels ; this feature, however, was not novel, having been used frequently for moving military towers.

* The removal of masonry buildings while families were residing in them during the operation has been accomplished successfully a number of times in America. The writer of this paper removed a factory chimney eight feet square at its base and 100 feet high, weighing by computation 170 tons. The operation was entirely successful, and the cost much less than a new chimney.

LABOR'S DELUSION REGARDING CAPITAL.

By Alfred H. Peters.

THE belief prevails among many members of the laboring class, more especially among the organized bodies therein, that the chief obstacle to their advancement, both material and immaterial, is capital, or wealth employed in the production of more wealth. It is easy to prove, on the contrary, that capital is the least of the forces against which labor has to contend ; that it is not so much an active force as a passive instrument in that contention, and that if labor had no other force to contend against it might, whenever it chose, put capital under its foot. Let the intelligent laborer but reflect upon the situation and he can hardly fail to perceive that it is not capital, but forces infinitely more powerful, that takes advantage of labor ; forces that take advantage of capital no less than of labor,—the forces of intellect and of will.

Suppose that all capital, all money, all investments of money, were to be turned into ashes or sunk within the bowels of the earth —what would be the result ? The purely capitalist class, those whose incomes are derived from rent, interest, or any other return that comes not through individual effort, would indeed for a brief time cease to be an element in industrial economy ; but does any one suppose that the action of that economy would change ? Not at all. Society would forthwith reorganize upon the same general line as before. The keenest heads would be in most demand, and therefore receive the highest reward, while the dullest heads would be in least demand, and therefore receive the lowest reward ; between which all the other heads would be ranged with positions and rewards according to the degrees of skill and intelligence. First would be preferred the men of organizing and directing ability, hard upon whom would follow the men of persuasive ability, who would themselves be followed by the men of foresight and invention ; and so on down through the different orders of ability to the man whose only ability was his muscular force,—always underderstanding, however, that human nature continued the same, and that the most part of human energy was expended to the end of individual aggrandizement. Against this inequality in social organization no laws or institutions avail, because it is nature's fixed decree that mind shall be the master and muscle the servant.

In this manner would intellect assert its supremacy. At the same time the other master faculty, will, the foundation of whose power is diligence and self-restraint,—less imperious but more persistent, and in the long run more certain than intellect,—would also assert itself. Everywhere would be found those who, how small soever might be the value of their energy, would assiduously exercise it and reserve the greater part of their return therefor. Intellect often is spendthrift and ready to mortgage itself to the future, as well as being generous withal, but will, when bent upon fortune, lives only in the future and is, respecting the present, as merciless to others as to itself. Little by little, with indefatigable resolution and self-denial, would this hard but conquering force in an increasing ratio make itself a social power. It matters not what might be the object of accumulation—money or bonds or houses or lands or cattle or slaves—so long as it was the object of man's desire. Out of this genius for accumulation capital is for the most part created ; and, as in the case of intellect, no laws or institutions avail against it, because he who lives for the future shall survive and he who lives only for the present shall perish.

Capital has been oftentimes, if not wholly, yet in large measure thus dissipated or destroyed. The thirty years' war devoured the accumulated resources of Germany ; the French revolution and the wars of the first empire consumed the surplus wealth of France, and the American revolution ended with the practical disappearance of capital from the colonies for nearly a generation. None of these convulsions, however, changed the fundamental principles of social economy. Men went to work directly, as order was restored, with mind at the head and muscle at the foot as before ; every one expending his energy as best he might to the end of satisfying whatever was uppermost in his desire. The only difference between a society with capital and a society without capital in respect to rank is that in the former condition intellect becomes the head in name as well as in fact ; whereas in the latter condition intellect often is content to remain the head in fact while permitting capital to become the head in name.

Now it is here maintained that this capitalless condition is at all times the real condition of the most part of productive human energy. Ninety-nine hundredths of the intellect and will, as well as of the muscle, that come into the world come into it with no other capital. The only office that capital performs is to increase human activity and productiveness. Wherever there is capital, there will be found the greatest number of those desiring to use capital ; and wherever capital finds most employment there always does the most labor congregate. Not only from its own land but from every other land is labor attracted toward good management and thrift, of which capital is no more the enemy than it is the enemy of labor. Rather is capital the friend or would-be friend of all three,—inasmuch as it is the means whereby they obtain a fuller satisfaction of their desire. When labor can find no employment it is either because capital has been destroyed, or because intellect falls out or overreaches itself, or because thrift becomes frightened and withdraws its store from use.

Labor is a tax paid either by ignorance to intelligence, or by self-indulgence to self-restraint, a tax from which capital cannot escape any more than can labor. Consider the constant exactions and depredations to which, from both these forces, capital is obliged to submit,—the thousand devices whereby astuteness, or intellect, frightens or befools or forces capital into gratifying its desire. Consider also the habitual toil and frugality whereby self-restraint, or will, constantly increases the volume of capital ; the value of which is thus diminished and the return thereon reduced. Labor cannot be long taxed to its destruction, nor to a degree whereby it ceases to be productive, but capital often is forced to risk annihilation in order to become productive. Labor does indeed often lose much through the devices of intellect, but capital through the same devices often loses all ; in which case its former possessor, when it is his sole possession, becomes of all men the most helpless. Moreover, the men who are the most successful users of capital, and therefore the greatest concentrators of capital,—men in whom superior intellect and superior will are united to the end of personal emolument,—come in the majority of instances from labor's own ranks. The greatest managers and accumulators of capital are for the most part men who, or whose fathers, were born of parents belonging to the laboring class.

No one denies this fact : that the creators of capital, from the savings-bank depositor up to the director of vast industries, are commonly sprung from the laboring class of society. The man of inherited capital is seldom a moving-spirit in the industrial world. He may be the nominal head of some industrial or commercial enterprise, as formerly a prince of the blood was the nominal head of some military enterprise, but the real head—he upon whom the success of the enterprise most depends—probably began life with no other capital than a clear head and a stout heart. When one thus equipped is discovered capital fairly throws itself at his feet. Instead of endeavoring to retard the intelligent and resolute son of labor, capital is constantly endeavoring to advance him ; provided always that his intelligence and resolution be exercised upon traditional and established lines. Capital is loath to further innovation or to exalt individual independence. It is always upon the side of authority, and expects subservience on the part of the other forces of society, as it is always subservient itself.

Who are the capitalists? Those whose fathers or grandfathers were enabled through genius, or talent, or courage, or accident, or subservience to leave fortune to their offspring,—the class of leisure and of fashion? Those who have built up great manufacturing, or distributing, or carrying enterprises,—captains of industry so-called? Those who deal in money and loans and credits,—the directors of great banking and trust institutions? As commanders of segregated capital these may be better known and individually more important, but of capital in the aggregate they own but a fractional part. The bulk of capital is owned by those whose labor, either for themselves or for others, is labor of the hands more than of the head. Consider, in addition to the accumulations of hired laborers, the accumulations of laboring proprietors,—small farmers, artisans, and traders,—whose labor, being mostly of the same kind as that which they employ, makes them, economically speaking, as much laborers as proprietors. Consider the aggregate of savings-bank deposits, of life-insurance policies, and of all manner of small investments, to say nothing of the farmsteads and the homesteads, the tools and the implements which are the property of the laboring and semi-laboring classes. Every laborer or laboring proprietor who has reserved a portion of the product of his labor is relatively just as much a capitalist as are they who employ his savings, and oftentimes more so.

More than the dependence of labor upon capital is the dependence of capital upon labor. Were labor to cease capital would soon perish. The store of that which sustains civilization would without replenishment be exhausted in a few years, and the store of that which sustains life is never sufficient for more than a year in advance. The enemies of capital should have lived during those ages when man's main business was war—the destruction instead of the production of capital ; when whatever industry that existed was left to women or to slaves ; when a short supply meant a raid upon one's neighbors, and famine was at all times never very far off. Do those who inveigh against the industrial system ever consider what has been, economically speaking, the principal result of that system? It has been an enormous increase in the volume of civilized human life. Everywhere the most industrious nations are the most populous nations. The more industry, the more life. If the creation of capital, and consequent industrial development, be an evil, the way to diminish it is to diminish the quantity of life.

It is not to be denied that industrial civilization bears hard upon labor,—in respect to the concentration of energy and individual responsibility harder than when the laborer was a chattel or a feudal appendage; nevertheless labor would not exchange the free service of railway and factory proprietors for the enforced service of barons and bishops. Herein also the grievance of labor is no greater than the grievance of every other form of human energy that is in the market. He who would in our time find employment at another's hands must apply himself strenuously toward his employer's ends, whether his work be of the hand, the head, or the heart; and whosoever would enjoy freedom must accept responsibility therewith. Let not this or any of the other grievances whereof labor complains be charged upon capital, however. They are to be charged, if chargeable at all, upon the mind that is behind capital,—human intellect devoted to progressive, or speculative, or competitive ends. He from whom labor suffers most, be it the method-displacing inventor, the ambitious ruler, the enterprising projector, or the close-calculating industrial manager, is always and everywhere the incarnation of some master mind. Of such ones capital may and may not be the instrument. James Watt without capital rendered useless the skill which labor had acquired through the practice of many generations. Bonaparte without capital forced into arms half the labor of Europe, and the late Jay Gould, during a large portion of his career, with comparatively little capital controlled the labor of an entire railway system. The injury done to capital in every one of these instances exceeded the injury done to labor a hundred-fold.

Nor must the grievances of labor be charged wholly upon the master directors of industry—the ones that through any means whatsoever disturb the conditions of labor or dictate the terms of its employment. The greater part of the professional class, as well as of the trading class, are as much responsible for the advantage taken of labor as are the master managers of industrial enterprise.

Every one who obtains a livelihood through the ignorance, or credulity, or vanity, or curiosity of labor ; every one who caters for his own profit to its appetites and passions ; the demagogue who obtains office by flattering it, the agitator who lives by inciting it to idleness and violence—is not labor a constant sufferer from all of these? Indeed he who possesses just enough intellect and just enough will to raise himself one degree above the average circumstance of labor is, when he sets about beguiling it, the one from whom labor suffers most.

If labor would escape subjection to these master faculties, and at the same time preserve its freedom, it must acquire them itself. In every advantage taken of labor it is itself, through lack of these faculties, in more or less measure an accomplice. Every abuse of legislative or of proprietary or of managing authority, as well as every professional device whereby labor is taxed for the gratification of individual pride, or ambition, or ease, or greed, exists only by reason of labor's deficiency in intellect or in will. And labor is acquiring these faculties and has been acquiring them for the last hundred years. Herein labor has advanced just far enough to be conscious of its strength ; and, feeling that some force is operating against it, charges the offense upon capital, the mere instrument of the offending powers. It is to be noted that the strongest of the labor organizations are those whose members are skilled laborers, and therefore the more intelligent and self-restrained. The question for labor to consider is whether it can gain most by individual action or by collective action. Individual action permits the intelligence and self-restraint among labor to rise and take its place alongside other intelligence and self-restraint. Collective action, upon the principle of arbitrary equalization, chains him in whom the master faculties are developed to the mass of those in whom they are undeveloped. Labor may not emancipate itself by forcing a self-denying ordinance upon intelligence and thrift, nor destroy the opportunity of any other class of society without at the same time destroying its own.

In proportion as individual energy is free, in like proportion is the reward of individual ability. Nay, in like proportion also, when more than one generation is considered, is fortune most evenly distributed. The denunciations against the individualistic economy come from men who are incomparably more selfish than the individualist,—men whose desires and expectations are centered in the present if not in themselves. Consider the course of fortune for the last hundred years in the United States. Who are the men of greatest fortune among us to-day? The descendants of the Dutch patroons or of the English patentees or of the opulent colonial merchants of Boston, Philadelphia, and New York,—the landlords and millionaires of a century ago? On the contrary they are the descendants of those who a hundred years ago were impecunious professional men, or farmers, or craftsmen, or European peasants; in many instances men who began life as such themselves. Meantime the descendants of those whose names a century ago stood for power and affluence may be found depending upon daily toil for their subsistence. The same process has been going on in Great Britain, notwithstanding the legal barriers that still remain, and wheresoever else individualism has obtained against paternalism; and the result will be the same during the next century as during the present one. The free play between those who have and those who have not, from one generation to another, is the surest equalizer of human fortune.

In these forces of intellect and will is involved the whole matter of man's inequality, which, like every other human question, is mainly a question of degree. The man who in civilized life is at the bottom of society would, if he were thrown among a tribe of savages, be at the top of society; as shipwrecked sailors become dignitaries among the South Sea islanders, and escaped convicts the patriarchs of the Australian bush. Intellect is master of men because it wields weapons which the mass of men are unable to wield; and will is master of men because for the sake of ultimate gain it denies itself that of which the mass of men refuse to be denied. This inequality is felt by the purely capitalist class as much as by the purely laboring class, many of which envy nothing so much as superior intellect and superior will, and many more of which sorrowfully confess that material abundance and refinement have served them but as an enemy in all strenuous endeavor. Man is by nature a discontented animal. Satisfy one of his desires and forthwith he feels the sting of another. He who supposes discontent to be peculiar to one class of society is but a poor student of human life. Many specifics have been prescribed for man's discontent, none of which avail because, instead of a malady to be cured, discontent is that part of the divinity within him. The only medicine that assuages this divine discontent is persistent endeavor, lack of opportunity whereof toward some manner of improvement is the only grievance of which man may justly complain.

INDUSTRIAL CONDITIONS IN MEXICO.

By John Birkinbine,

Past-President American Institute of Mining Engineers.

MEXICO has been described as "a country of contradictions"; it certainly is a land where extremes meet most unexpectedly. The traveler will find long stretches of nearly level plain terminating abruptly in high mountain ranges, whose steep sides obstruct any passage more pretentious than a burro-trail. From the unwatered desert with its sparse vegetation of sage-bush and cacti, a few steps transport one to luxuriant growths of plants and trees in great variety, stimulated by irrigation. On Sundays and feast-days in the Alameda of the capital, or on the plazas of other Mexican cities, the sandalled feet and scant clothing of peons and Indians are intermixed with elegant and costly costumes worn by bejewelled señores and señoritas, with their "proud Castilian bearing." From the windows of railway-cars one may see men, women, and children carrying heavy burdens and maintaining a jog trot in competition with traffic by rail and steam. In the mineral districts modern steam or electric machinery elevates water and ore, while in adjacent mines notched sticks serve as ladders, and *bateas* of hide containing water and ore are lifted by oxen dragging around the bars of *malacates*, or even by manual labor. The new drainage canal for the city of Mexico is being excavated in part by improved steam-dredges, and in part by peons clad only in sandals and breech-clouts, who carry on their backs *morales* filled with earth. Many other such surprises could be suggested to illustrate the close association in Mexico of the old and the new which exerts such a decided influence upon industrial development in that republic.

In the past decade Mexico has made great advances, and there is reason to believe that the future will be marked by greater progress. But new enterprises for the near future must be based largely upon a condition of affairs closely allied to that now existing. The country cannot in fairness, however, be judged by its status prior to the development of its railways. These have caused modifications and changes appreciated only by those who knew Mexico before the locomotive wakened the echoes of its cañons. While its traditions and customs which have been recognized for centuries still prevail, Mexico is making advancement which must be recognized in discussing any projected investment; yet the peculiar environments must not be overlooked.

Some of the conditions which will confront Mexican enterprises demand radically different treatment from those which prevail in the United States, and a failure to appreciate these is emphasized by plants of expensive machinery bought for use in Mexico which either lie idle or have been relegated to the scrap-pile. The more prominent conditions to be considered in establishing industries in Mexico are (1) an abundance of cheap labor; (2) concentration of the bulk of the population in limited areas; (3) great distances and differences in elevation to be overcome in bringing various sections of the country into trade relations; (4) a general scarcity of domestic fuel; (5) comparatively restricted capital; and (6) intermittent or uncertain water-supply.

Of the 11,600,000 souls constituting the population of Mexico, fully two-thirds may be classed as peons (laborers) and their dependents, the great mass of whom, by reason of their habits and their taste for games of hazard, are in debt to their employers and are practically serfs. Labor consequently commands a low rate of compensation. The *Two Republics*, an English newspaper published in the city of Mexico, said in a recent editorial: "It is officially announced that the average daily wage in this country is 27 cents. This is probably at least 10 cents more than it was twenty years ago. In ten years we believe it will average 50 cents."* The writer has found through personal inquiry that in various portions of the republic laborers receive for working "from sun to sun" from 18 to 75 centavos, according to the tasks assigned and the section of country in which the labor is performed. The maxima and minima of wages paid are therefore from 9 to 13 and 38 to 56 cents per day, in United States money. This labor, though cheap, adapts itself readily to changing conditions, and consequently is a drawback to the use of labor-saving appliances.

The total area of Mexico is 767,206 square miles, with an average population of 15 per square mile. The eleven "central States" have an area of but 18 per cent. of the whole, while their population represents nearly 50 per cent. of all the inhabitants of the

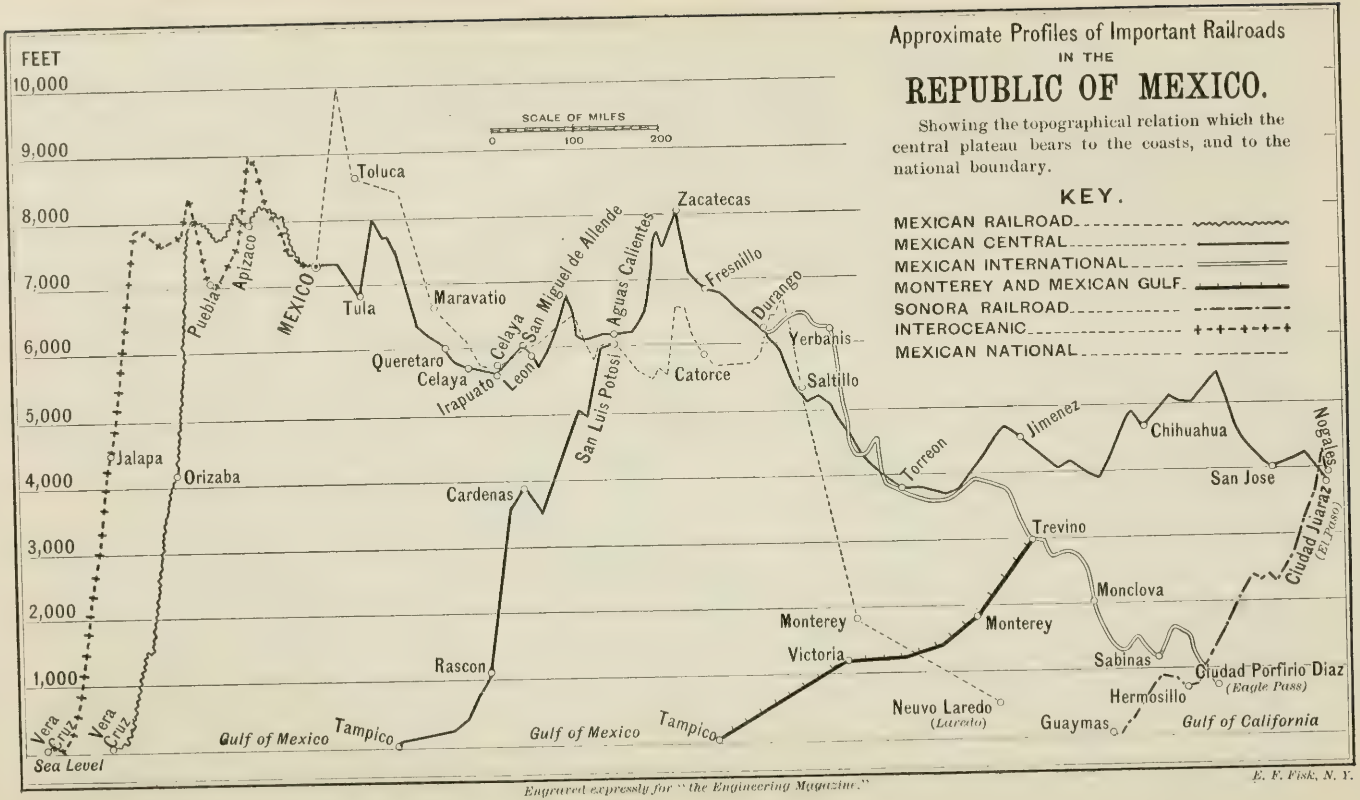
* The "cent" referred to is the *centavo*, of which 100 are equivalent to one *peso*, or Mexican dollar. It has a commercial value varying, with the rate of exchange, from one-half to three-quarters of a United States cent.

republic, the number per square mile being 39. A circle having a radius of 100 miles from the city of Mexico would include a population of nearly 2,500,000. In this area are numerous towns of large size and commercial importance. If a radius of 200 miles were used the circle would include the gulf ports of Vera Cruz and Tuxpan and the Pacific port of Acapulco, and embrace a population of fully 5,000,000. Nearly half of the inhabitants of the republic, therefore, reside within 200 miles of its capital. The remaining half of the population is scattered throughout eighteen States and Territories, averaging less than 10 per square mile. As the remote States include some important cities and populous districts, it is evident that much of the area is sparsely settled, and that, outside of the merchants in the cities and the owners and managers of haciendas and mines, the great majority of the people in these States may be classed as peons.

The greatest width of the republic (750 miles omitting lower California) is at the latitude of the mouth of the Rio Grande, and but about half that distance at the latitude of the capital, the width continuing to decrease to the isthmus of Tehuantepec. In crossing from the United States into Mexico a rapidly-increasing elevation is found as the Rio Grande is ascended, this increase being from ocean level at Matamoras to 3700 feet at Paso del Norte, and between the latter point and the Gulf of California greater altitudes are encountered. Humboldt is credited with the assertion that the so-called great central plateau of Mexico could be traversed anywhere between the mountain chains by a stage-coach, and to-day the Mexican Central railroad tracks follow this plain, having a general ascent from Paso del Norte to Zacetacas and the city of Mexico, each approximating 8000 feet. As this so-called great plateau is bounded and intersected by mountains reaching much greater elevations, the coasts of either the Gulf of Mexico, the Pacific ocean, or the Gulf of California can be reached from it only by long detours or abrupt ascents and descents.

Mr. E. Prieto Basave states* that in 1891 about 6,000,000 passengers and 3,000,000 tons of freight were carried, and estimates the earnings of the railroads of Mexico during 1892 at 12,000,000 pesos. He gives the total cost of all Mexican railroads, aggregating a length of 6389 miles, as $200,000,000, of which $76,000,000 was advanced by the government in subventions, the balance being principally American and British capital. Most of the roads have

*Transactions American Society of Civil Engineers, Vol. XXIX.



Engraved expressly for "the Engineering Magazine."

followed the great plateau, and in but few instances have the lines constructed had to overcome the gradients and developments necessary to reach the high lands from the comparatively narrow strips of *terra caliente* which skirt the gulfs and ocean.

In a recent address before the Engineers' Club of Philadelphia the writer made the following statement concerning the changes noted in eleven years, together with data upon the profiles of various Mexican railways, and the accompanying diagram* has been introduced to emphasize the statement as far as the main lines of the more prominent roads are concerned :

In a late trip I rode between 500 and 600 miles, in comfortable sleeping-cars over territory which little more than a decade ago was accessible by slow, exhausting wagon-travel only, requiring camps on the plain, or stops at ranches far from other habitations. The story I then told to wondering, if not skeptical, natives, of travel at the rate of ten to fifteen *leguas* (twenty-five to forty miles) per hour in the United States, has become a familiar sight in daily railway trains ; and the new

* The diagram on the opposite page exhibits profiles of the main lines of the Mexican railroads named below, and one branch road, to show the general topography as affecting avenues of communication:

The Mexican railroad (standard gage) follows a general easterly course from the city of Mexico to Vera Cruz (263 miles), the highest elevation reached being 8225 feet, the termini having heights respectively of 7350 feet and zero.

The Interoceanic railroad (narrow gage) also starts at the city of Mexico and pursues the same general direction to Vera Cruz, the distance between the termini being 342 miles. It reaches an elevation of 8967 feet. As the distance between the capital and Vera Cruz is greater by this railroad than by the Mexican railway, two locations for Vera Cruz are given in the chart.

The Mexican National railroad (narrow gage) extends in a northerly direction from the city of Mexico to Nuevo-Laredo (839 miles), at the Rio Grande boundary between the United States and Mexico, opposite Laredo, Texas. The highest elevation reached is 10,020 feet.

The Mexican Central railroad (standard gage) runs from the city of Mexico to Cuidad Juarez, also at the national boundary opposite El Paso, Texas,—a distance of 1224 miles. The greatest height reached is 8045 feet. This railway is shown by a full line, as is also a branch line connecting Aguas Calientes, on the main road, with Tampico. This branch is 415 miles long, but to keep the diagram distinct only 275 miles from San Luis Potosi to Tampico are represented.

The Mexican International railroad (standard gage) is completed from Ciudad Porfirio Diaz (opposite Eagle Pass, Texas), to Durango (540 miles), crossing the Mexican Central railroad at Torreon. The exploited coal deposits referred to by Mr. Robert T. Hill are in the vicinity of Sabinas on this road. The road at one point reaches an altitude of 6503 feet, the general direction followed being southwesterly.

The profile of the Monterey and Mexican Gulf railroad (standard gage) is incomplete, data for a few prominent points only being accessible. It extends in a general north-northwest direction from Tampico (387 miles), crossing the Mexican National railroad at Monterey, and connecting with the Mexican International at Trevino, the present terminus. The greatest height reached is at Trevino, 2920 feet. To show the proper connection of this railroad with the Mexican International railroad, Monterey is indicated in a different position from that designated on the Mexican National railroad. A similar duplication of the stations at Celaya is indicated on the Mexican Central and Mexican National railroads, these two railways crossing at this point, and Tampico is shown in its proper relation to different connecting points.

The Sonora railroad (standard gage) has a southern course from Nogales, on the Arizona border, to Guaymas, on the Gulf of California, a distance of 265 miles. The highest point reached is at Encino, 4284 feet.

conquest of Mexico by the engineer is an accepted fact. . . . Of the tracks of railroads in the republic of Mexico the altitudes are as follows :

Above Sea-Level.	Proportion.
Less than 1000 feet	15 per cent.
Between 1000 and 2000 feet	10 per cent.
Between 2000 and 3000 feet	6 per cent.
Between 3000 and 4000 feet	10 per cent.
Between 4000 and 5000 feet	13 per cent.
Between 5000 and 6000 feet	15 per cent.
Between 6000 and 7000 feet	15 per cent.
Between 7000 and 8000 feet	13 per cent.
Between 8000 and 10,000 feet	3 per cent.

To summarize this table, three-fourths of the entire railroad mileage in Mexico is at elevations greater than are reached by any of the Pennsylvania railroads, and about one-half of the Mexican tracks are below, and one-half above, a level of 5000 feet ; of the higher portions some 200 miles are laid from 8000 to slightly over 10,000 feet above sea-level.

Of twenty Mexican cities which in 1890 had populations exceeding 20,000, all but two are located at elevations between 5000 and 8000 feet above the ocean level. Owing to the topographical features referred to, most industries to be successful in Mexico should be located at or near sea-level, or on the great plateau at elevations of from 5000 to 8000 feet above tide.

The great cost of the Mexican railroad from Vera Cruz to the city of Mexico, the difficult and expensive work on the Interoceanic (narrow-gage) railroad between the same termini, as well as upon the branch of the Mexican Central railroad from Aguas Calientes to Tampico, illustrate the character of natural barriers to be overcome in reaching the great plateau from the coasts. This is further shown by a study upon railroads from Guadalajara to the Pacific coast by S. V. Pascal,* in which the author describes three proposed routes, respectively 216, 269, and 250 miles in length, with 2, 2½, and 3 per cent. grades, which he estimates will cost for construction from $40,000 to $44,000 per mile, independent of the right of way, stations, plans, and supervision.

The fuel problem in Mexico demands serious consideration. Mr. Robert T. Hill, in a paper on "Mexico as an Iron Producing Country,"† refers to the coal-mines which are wrought in the northern part of the republic. A map accompanying his contribution shows graphically that all of the present developed coal-fields are far removed from most of the centers of population. In addition

*Transactions American Society of Civil Engineers, Vol. XXIX.

†The Engineering Magazine, February, 1893, pp. 744-753.

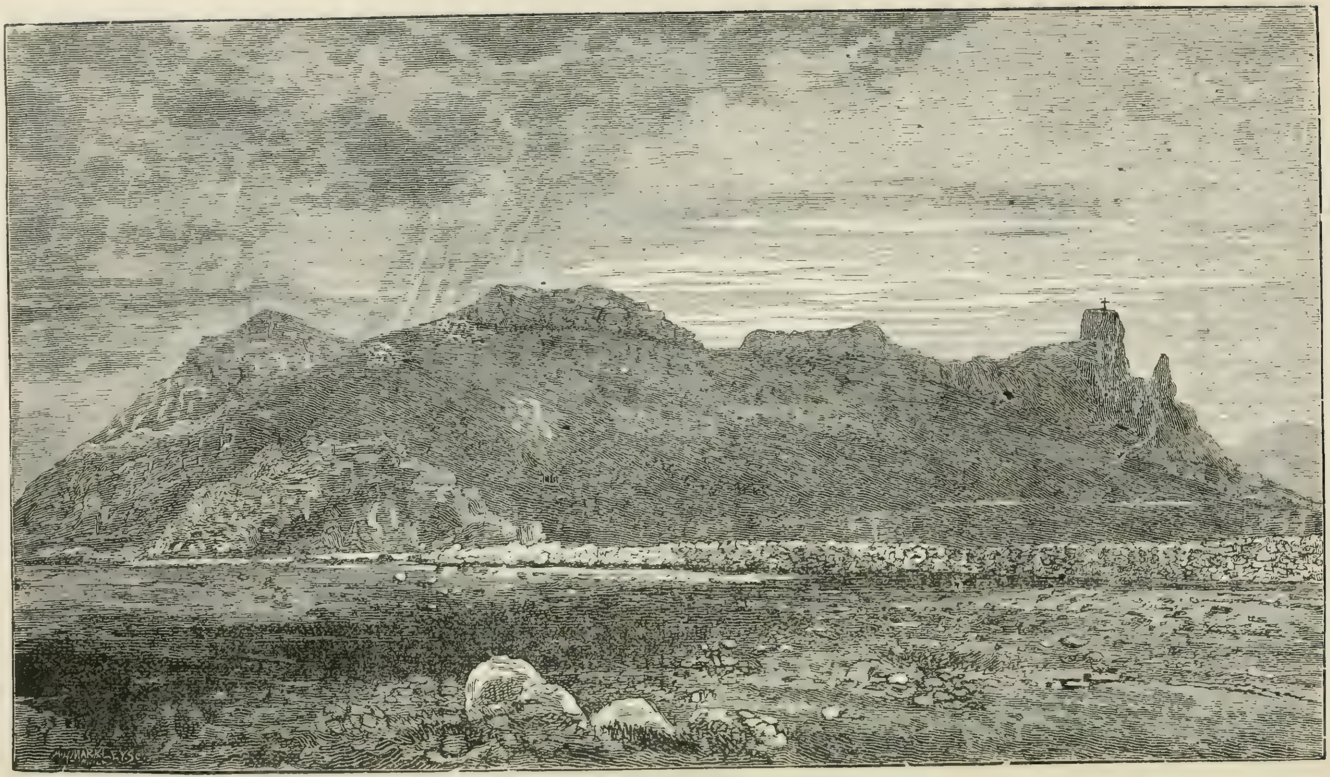
to the distances to be overcome, the fact that the most productive coal deposits are located at an elevation of but 1000 feet above tide, while the bulk of consumption is at elevations between 5000 and 8000 feet, affects the practical application of that fuel to a considerable degree. The numerous reported discoveries of coal elsewhere either have been insufficiently exploited, proved to be of inferior quality, or are now inaccessible even for thorough investigation, so that practically the entire dependence of the republic is upon the northern coal-fields, or upon coal imported from the United States or Europe. It is probable that subsequently exploited coal deposits will be at locations demanding that their product be hauled up steep grades or over considerable distances to reach the main plateau. English bituminous coal delivered in the city of Mexico in April, 1893, cost $17 in Mexican money, per metric ton, and Alabama (United States) bituminous coal cost $21. Coahuila coal cost, delivered in Puebla, $26 per ton.

Except in the mountain fastnesses, or in territory which, with existing methods of transportation, has been practically inaccessible, the scarcity of wood restricts its employment in industries. In the hot lands much of the timber growth is of classes too valuable to use for fuel or of inferior calorific importance.

A nation which, within the limit of an average human life, has had such varied forms of government, so many internal dissensions, and so little encouragement to develop its manufactures, can hardly be expected to have capital in excess, but must naturally look to other countries for money to assist in its material advancement. The problem of establishing Mexican industries, therefore, is beset by financial difficulties greater than are to be found in some other nations. The recent railway development has shown, however, that foreign capitalists have had no little faith in the future of the republic, for they have invested more than $100,000,000 in these enterprises, in addition to large sums in its industries.

Long droughts, intensified by the general absence of perennial snows, followed by intermittent and heavy rain-falls, are not conducive to the location of industrial centers, except where these conditions are modified by such natural or artificial facilities as improve the permanence of the water-supply. The hygrometric conditions which prevail over a large part of Mexico may be summarized in the above statement.

The foregoing considerations being applicable in whole or in part to all manufactures, it is now proposed briefly to consider them



THE CERRO DE MERCADO (IRON MOUNTAIN) AT DURANGO, MEXICO.

[From Transactions of the American Institute of Mining Engineers.]

in relation to the production of iron, supplementing the admirable article in THE ENGINEERING MAGAZINE of February, 1893. This article refers to various Mexican iron-ore deposits, and additions to this list could be furnished to show the extent and variety of accessible ores. Such detail, however, is not essential for present purposes, but it appears proper in this connection to state that a recent visit to the Cerro de Mercado at Durango confirms the opinion which I expressed in 1882, and which is quoted in Mr. Hill's contribution, that this is the largest visible known deposit of iron ore. I do not coincide, however, with the view expressed that most of the Mexican iron-ore deposits are analogous to those of the Cerro de Mercado and Monclova, for some of those which have been personally examined vary in physical structure and chemical composition, and differ mineralogically and geologically from the Durango and Monclova ores. While there is no lack of iron-ores, many of which are of a satisfactory character, the use of these will depend upon the facility with which they can be assembled at points where fuel is sufficiently abundant and cheap, and from which manufactures can be distributed advantageously. The abundance of limestone in Mexico makes the supply of suitable flux an easy problem for a number of available furnace sites.

The most modern iron-producing plant in Mexico is at Durango, where the ore problem is readily solved, the furnace being under the shadow of the great mountain of ore, but the nearest known supply of coal is 450 miles distant, at a level 5000 feet below Durango, while for smelting purposes its quality is open to criticism. To obtain wood or charcoal of satisfactory quality in sufficient quantity it will be necessary to convey these 40 miles to Durango, constructing a railway for the purpose. Up to the present time fuel of this character has been obtained nearer, at scattered locations, and brought in by *burros* and *carretas*. Another apparent drawback to the Durango location is its distance from a population which could consume a large portion of its products, and yet with these disadvantages an iron industry should be operated successfully in this locality in competition with imported materials on which duties have to be paid.

The other active iron industries of Mexico consist of less modern structures, located generally in closer proximity to the bulk of the population, and several are convenient to excellent ores and an abundance of wood. But these sites in the heart of the mountains demand expensive and troublesome transportation to reach a market. Several of the smelting-plants have rolling-mills and foundries attached, but in most cases castings are made directly from the furnace, the molten metal being ladled from a fore-hearth ; in one case a steel-works is in course of construction. A number of foundries are located in the cities, using scrap iron principally, with imported pig-metal, and there are also independent rolling-mills and wire nail-works, the latter using imported bars.

In several foundries and machine shops visited by the writer most of the employés were Mexicans, and an inspection of their work on lathe, planer, or drill-press, at the vice, forge, or pattern-bench, demonstrated a natural ability requiring only cultivation to develop mechanics. While the ordinary wage rate is low, skilled help commands prices equalling and sometimes exceeding those prevailing in the United States for similar work.

The policy of the Mexican government has been to protect its industries, and this policy is likely to continue if sufficient advancement is made to warrant governmental support. By far the larger portion of the manufactured iron and steel which has been used in Mexico is of foreign production, concessions having been made which permitted most of the railroad companies to import duty free all materials necessary for the construction, maintenance, and operation of their roads. These requirements can be interpreted to cover nearly every kind of manufactured iron and steel and machinery, but the concessions are limited as to time, and the progress of the domestic industries probably will influence extensions of these privileges. From what has been stated concerning the conditions which influence the establishment of industries in Mexico, there would appear to be an advantage for selecting sites for iron manufacture upon the higher lands and within as short a distance as possible from the consuming population. The product of works so placed would have, in addition to any protection offered by the government, a further protection from foreign-made material which, after being transported by water, must be raised by steep gradients on railroads which consume expensive imported fuel. The cost of carrying coal, and in many cases water, to supply the motive power, must have the effect of maintaining high freight rates if the railways are to earn a profit. The prices for iron prevailing in the spring of 1893 in the city of Mexico were : Bar iron, ordinary sizes, 8 to 12 centavos per pound ; ordinary castings, 10 to 12 centavos ; nails, 12 to 14 centavos per pound.

The demand for iron and steel in Mexico embraces practically most of the products and manufactures required elsewhere. The railways will be extended, but their immediate development will be confined principally to feeders for existing lines, for the policy of the government will hardly favor further subventions except for roads of special importance. Such extensions, together with track-renewals and sidings on existing lines, will require considerable quantities of rails, spikes, bolts, and metal ties (the latter being preferred on several Mexican lines), while locomotives, cars, wheels, couplings, etc., will demand renewals and reconstruction.

In view of the scarcity of metallurgical fuel and the necessity of producing steel on a liberal scale to secure economic results, it is probable that rails for Mexican roads will continue to be imported, and especial advantages possessed by large industries confined to the manufacture of locomotives will interfere with the construction of these in Mexico. But with the concessions removed which have permitted the free entry of other railroad material, there is a good opportunity for home production. The manufacture of structural iron seems to offer a good field where long or heavy timber is expensive, and it is probable that the moderate climate will encourage the continued use of iron grillings for windows. Nails, sheet metal, and merchant iron and steel also suggest profitable ventures for industries well located and managed.

The superiority and cheapness of Mexican earthenware and the use of open fires must to a considerable extent interfere with the employment of iron household utensils, while the necessity for stoves will not appeal forcibly to natives to whom the sudden but generally moderate changes of temperature cause little discomfort. But there is a demand for stoves and hollow-ware, which will increase as their use is appreciated and mineral fuel becomes more accessible. The public supply of water under pressure is supplanting the aqueducts and open *acequas*, and municipalities will need iron water-pipe, special castings, and hydrants. Mines will also demand conduits for water and machinery, but much of the latter will be obtained best from manufacturers who make this a specialty. Wagon-tires, axles, agricultural implements, and machinery will gradually replace the cruder appliances in common use.

The abundance and cheapness of labor, while offering advantages for securing workmen, emphasizes the fact that a large proportion of the population of Mexico can be looked upon as purchasers of but little of the manufactured products until these can be offered at prices much below those now prevailing, and the distances to be covered in distributing the articles must add to their cost to the consumer.

Mr. A. Falkenau, who visted Mexico to study the opportunities for opening a trade in mining machinery, says: "American engineers have charged that the only reason preventing the introduction of machinery is the absurd reverence in which the Mexican holds the customs and manners of Montezuma's time. . . . There is no doubt some foundation for this charge, but upon closer investigation I became convinced that a great injustice is done to Mexicans. The true key to the cause of their opposition to the introduction is to be found only by a study of the topography, the natural resources, and the political condition of the country."

In presenting my convictions concerning the extension of the iron industry in Mexico, I am far from desiring to minimize the resources of the country, or to discount the probability of their utilization. A territory rich in minerals, peopled by a race who are really industrious, living in a climate which enraptures most visitors and which encourages a luxurious vegetation, must prosper under enlightened progressive leadership and increased educational advantages. Such prosperity will come more quickly when advances are made with a knowledge of conditions as they exist, than if enterprises started upon wrong ideas convey this knowledge through disastrous failure.

The romances of the fabulous wealth of the Aztecs and the millions of bullion lying in waste-piles in old mines have led to investments which have brought injury to Mexico. The labor which for a few centavos per day will "dog-hole" a mineral deposit and inspect each individual piece of ore is not of the sort to throw much treasure on dump-piles. In some cases modern methods of extraction may permit the recovery of what was formerly wasted, but as a rule mining in Mexico is the same as elsewhere,—profitable only when well planned and efficiently managed. The climate of the low country favors the growth of cotton, coffee, and sugar; the elevated grazing grounds will support herds and flocks from which hides and wool can be gathered, and these, together with other products, can be manufactured where a consuming population is easy of access. Under intelligent administration, diffused education, improved methods, and common-sense practice the wealth of Mexico will excel the fabled glory of the Montezumas. But he who expects this wealth to drop from the heavens as generously as meteoric stones were showered upon Mexico will reap only disappointment.

ROAD-BUILDING IN A SOUTHERN STATE.

By D. A. Tompkins.

THE question of good roads is not one of construction alone, but of development and maintenance as well. The first settlers of the various American States were unable to spend much money or labor in road-making, but had to be content with clearing away the forest from a strip of ground twenty or thirty feet wide, which they called a road. In sparsely-settled counties in some States to-day this simple method of opening a way through a forest, at a cost of from $20 to $100 per mile, may be a heavier burden upon the community than the construction of a line of railway in some other section at a cost of $50,000 per mile. Between these limits of expenditure discretion must be exercised as to the best kind of road that the amount and character of traffic will warrant.

Since most inhabitable places have become supplied with roads of some sort, questions of original construction will not come before the road engineer as often as plans for improvement. Assuming that a given community has reached that condition of development where its traffic has become important in volume and value, while its roads have been growing impassable through bad usage,—for this is generally the condition of things that excites interest in the road question,—what is to be done? The question is too broad to permit of any answer that will be generally applicable, so various are the conditions of topography, the materials available, the amount of road funds, the state of the roads to be improved, and the character of the traffic. Nowhere else, perhaps, is the need of improved highways more pressing than in some of the southern States, and it has occurred to the writer that some of the readers of the Magazine might be interested in an account of the success of a practical experiment in the betterment of roads in his own State—North Carolina,—which may be assumed to be fairly typical of this section of the Union. This choice of a State for treatment in this connection may be all the more proper for the reason that of late the holding of "road congresses" has been begun in North Carolina, as the outgrowth of which we may expect that the work of improvement, so satisfactorily commenced in a few localities, may spread over all the neighboring counties. By the way, the utility of such conventions, as a means of concentrating the attention of the public upon questions of road improvement, may commend itself to the friends of the cause in other States.

It is important at the outset to consider that the highway alone does not afford a means of transportation, but the road and vehicles combined. Hence, in the construction of either a road or a vehicle, regard should be had for its effect upon the other ; neither should be formed in such a manner as to destroy the other. The

ROAD-BUILDING IN A SOUTHERN STATE—STRAIGHTENING AND GRADING.

sole of the human foot is broad enough to pack the soil into a hard, smooth surface, so that usage, instead of destroying a foot-path, commonly improves it. The old Indian trails, developed by this means alone, were for the uses of the Indian a far better highway than the average modern road is for the people who travel upon it. Most of our roads have been cut up by narrow-tired wheels, which soon produce ruts the bottoms of which are the most compact part of the road. In such ruts the wide tire wedges in be-

ROAD-BUILDING IN A SOUTHERN STATE—CONVICTS PREPARING MACADAM.

tween the sides, making the broad tired wheel pull heavy. The narrow tire, on the other hand, cuts most easily through the soft mud to the bottom, not wedging on the sides, and therefore pulls lightest. Consequently the mistaken conviction prevails in places that the narrow tire is the better one, though its easy pulling applies only on roads which have been cut up by the vehicle itself. But if broad tires had always been used, the point of contact of the vehicle with the road covering enough surface to make the vehicle pack the track it passed over, the result of usage might have been constant improvement of the road. There are, of course, soils too soft to support tires of any practicable width, making necessary artificial road-beds, of which more hereafter.

ROAD-BUILDING IN A SOUTHERN STATE—CONVICTS DISTRIBUTING STONE.

ROAD-BUILDING IN A SOUTHERN STATE—THE COMPLETED ROADWAY.

But to recount the North Carolina experiment. About fifteen years ago the mayor of the city of Charlotte* inaugurated a movement to have the streets, which up to that time had been clay roads, macadamized. The plan adopted was to have stone broken by hand and laid on the streets to a depth of six or eight inches, after making an equivalent excavation. With an expenditure of $25,000 about five miles of streets were put into fair order. The work was continued under successive administrations, with a continual improvement in methods, and the city now owns a well-equipped rock-crushing plant, the crushing of rock by hand having been abandoned.

As the street-building in Charlotte increased, the authorities of Mecklenburg county took up the subject of improving the highways outside of the city. The first important step was to secure from the State legislature authority to levy a road-tax of from 7 to 20

*The incumbent of the office then was William Johnston. Subsequently, under the administrations of W. C. Maxwell and F. B. McDowell, considerable work was done. The present mayor, Dr. R. J. Brevard, has done more work in street improvement than any of his predecessors. D. A. T.

ROAD-BUILDING IN A SOUTHERN STATE—THE OLD ROAD AND THE NEW.

ROAD-BUILDING IN A SOUTHERN STATE—A COUNTY CONVICT CAMP.

mills on $100 worth of the taxable valuation. The rate at present levied is about 15 mills, which yields some $36,000 a year.

Next the passage was secured of a law authorizing the county commissioners to take charge of all convicts sentenced by the city and county courts, the punishment for many offenses being a fine or so many days' work on the public roads. It is the belief in this county that this is the best possible disposition than can be made of the convicts, as they are not then brought into direct competition with honest, free labor, while their work inures to the direct benefit of the public.

The work of building, reconstructing, and repairing streets and roads in Mecklenburg is now in progress in three departments :

I. In the city of Charlotte, under the direction of the city council, by the mayor, city engineer, and supervisor of the streets. The work is paid for out of the city treasury.

II. The county at large, under the direction of the county commissioners,—a board of five, elected annually by a vote of all the magistrates in the county,—by the county engineer and the superintendent of the convict camp. Half the proceeds of the road-tax is disbursed by this board.

III. Each township, through its board of trustees, expends for local work in road-building one-half the proceeds of the road-tax raised within the township.

The city, the county board, and Charlotte township each own a plant, including a portable boiler, a slide-valve engine, a rock-crusher, a roller, and a screen made of boiler-plate perforated to separate the broken stone into three sizes, the largest being about 1½ inches square. In practice, the coarser stone is laid on the bottom to a depth of four inches ; the second size is laid next, three inches thick, and the fine stuff is used for a top-dressing of about two inches. Each of the three layers is well rolled as laid. The stone used in macadamizing is mostly furnished by the farmers after they have finished cultivating their crops. The price paid to them is 50 cents per cubic yard. The rock is delivered by them and stacked up at convenient points on the roads.

The work of the county commissioners, with convict labor, is the most interesting feature of all, and will be described more in detail. Originally the work done was the rounding up of the road-bed, cutting drainage-ditches, and excavating the center of them to a width of twelve feet and a depth of nine inches, the space to be filled with stone broken by hand. The system has now been developed until not only is the stone broken by steam-power, but roads are relocated, graded, and become practically new roads.

In Figure 1 is shown a cross-section of road-bed as constructed during the past year. It has been noticed that when the roads are

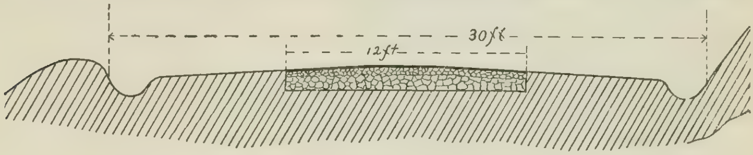


FIG. 1.

dry the clay road-bed is preferred by all drivers, and the location of the macadam in the middle of the road leaves either side too narrow for vehicles. Hence, in attempting to use the clay bed, the wheels of one side of a vehicle are always in the drainage-ditch, which spoils it. Now it is proposed to construct the road-beds as in Figure 2, omitting the paved gutters except where absolutely necessary. On this road-bed the macadam way can be used in the winter season and the clay road in summer. Besides the greater comfort of driving over the clay in summer, the macadam is protected from the unnecessary wear and tear of summer traffic.

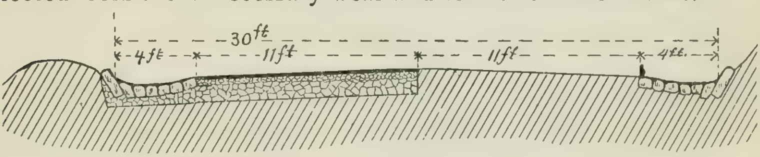


FIG. 2.

The use has been suggested of an iron roadway, as shown in Figure 3. It would be similar in form to a street-railway track, except that the rails are so shaped as to receive the wheels of vehicles of different widths. The section of the road between the rails would be macadamized, and the rule might be adopted of giving the loaded wagon right of way. A suggestion made by Mr. L. D. Ramsey, of Raleigh, N. C., is illustrated in Figure 4. He estimates that a roadway may be covered about as cheaply as it can be macadamized. The advantages claimed are of keeping the road-bed

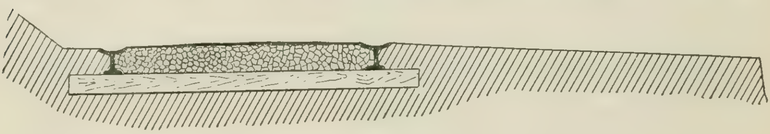


FIG. 3.

dry and of protecting travelers from storm and sunshine. The other illustrations accompanying this paper are made from photographic views of work in progress on the highways, designed to indicate the character of the improvement made.

The result of the work outlined here has been to lift Charlotte out of the mud and to make it a city of very clean streets and attractive appearance. In the county it has greatly increased the accessibility of markets to the farmers, besides furnishing attractive drives for the people of both city and country. All this has been brought about within a few years, without any appreciable burdens upon the people, in a section where, from time immemorial, the road-beds might have been compared to the tempering-pits in a brickyard.

The reports of the county engineer and the superintendent of county work show that the cost of feeding, clothing, and guarding convicts during the first five months of 1893 amounted to 20½ cents per day, the average number cared for being 91 per month. The report for June shows the cost per convict for each day *actually worked* to have been 31¾ cents. During the first nine months of that year an average of 90 convicts per month moved 36,247 cubic yards of earth on the roads, and crushed and placed 7381 lineal yards (4⅓ miles) of macadam, twelve feet wide. Five bridges were built or repaired during the same time. The total cost of the camp during nine months, including salaries, machinery account, and material, was $14,076.52. The last monthly report shows no convicts on the sick-list, and no escapes during the month. The convict camp is moved three or four times a year. In summer canvas tents are used. In winter the sides of the barracks are boarded up, leaving only the cover of canvas.

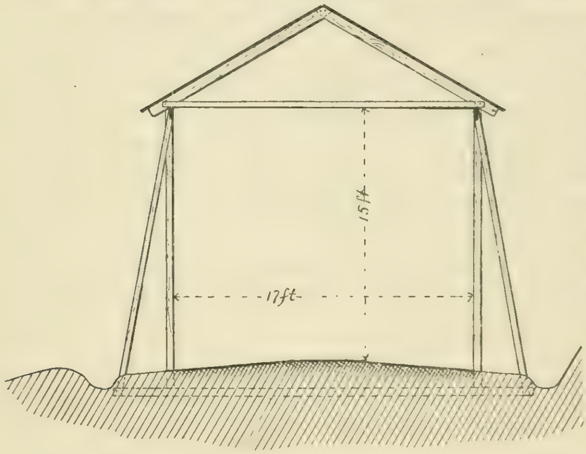


FIG. 4.

In Mecklenburg county it is considered important to avoid small wooden bridges, and to use terra-cotta drains instead. It is also believed that a depth of five inches of macadam would give as good service as the nine inches now used, if broad-tired vehicles were insisted upon and needed repairs were made upon the first appearance of a break. It is probable that the weakest point in the Mecklenburg system of road-making is in the matter of drainage.

The aim of the road commissioners has been to make all the available money go as far as possible toward giving better roads to the largest number of people possible, and to do the work in such a manner that the roads may be still further improved in future. To this end, the point has been made to perfect plans in every case before commencing work. The county now has about forty miles of reconstructed and macadamized roads. The total cost has ranged from $2700 to $4000 per mile, according to the amount and character of grading required. The value of the work to the farmers may be judged from the statement of Mr. B. H. Moore, one of the county commissioners, before the road congress at Raleigh. He said that before the roads were macadamized there were times when a pair of large mules could not draw a load of more than 1000 pounds from his farm into the city, whereas now they can, at any season, draw from 2500 to 3500 pounds. "The question now with us," he said, "is not what the team can draw, but what the wagon will hold up."

SMALL ELECTRIC-LIGHT STATIONS.

By J. E. Talbot.

THE business of electric lighting, in its commercial aspect and from the point of view of the central-station manager or owner, has been hitherto for the most part involved in mystery. Those who have made and who continue to make money desire, evidently, to confine their painfully-acquired knowledge to the esoteric few, while, on the other hand, those whose experience has been of a different character prefer to maintain a modest and discreet reticence on the subject. Thus, it has been difficult in the past for intending investors in this class of work to obtain unbiassed and trustworthy information.

Generally it has been impossible for two or three persons to discuss together the practicability of establishing an electric-light installation of moderate size without having let loose upon them a small army of the interesting and active promoter known as the "electric-light-man." These salesmen, almost invariably of a genial and hospitable turn of mind, usually make things "hum" locally, for a time, and when (if indeed the proposed investors have strength of mind left to postpone any definite action) their missionary efforts are ended, the promoters of the contemplated enterprise discover that they have added to their list of pleasant acquaintances and to their stock of good stories, but that their knowledge of electric-lighting matters, instead of being a simple *zero*, has now become a *minus* quantity.

Now, it is a curious condition that each of these representatives of competing, or ostensibly competing, companies, really does believe the system he represents to be the best in the world, and he acts according to his faith, if not beyond it, and here arises one of the difficulties that intending purchasers have to meet. This trouble is the tendency of every selling-agent to "go" the other fellow "one better." If A says that his machine will operate 500 lights, B says his apparatus, although designed for 550, will be perfectly good for 600, and so on, and it will be strange indeed if A, being thus challenged, does not rise to the occasion. Then the boiler-men and engine-men will have their innings, and, under competition, will cut their prices also (and quality at the same time) until, as the total result, the purchasers eventually start with a crippled plant—dynamos too small, engine- and boiler-capacity too small, and the quality of neither what it ought to be. By this time, moreover, the purchasers probably will have discovered that their plant is in a fair way to cost more than the amount originally believed to be sufficient. This means reduction in construction-expenses, poor poles, low-priced wire, and poor work,—all in the end expensive.

The results of this method of procedure are before long apparent in engine troubles, burnt-out armatures, hot boxes, grounded circuits, interruption of service, customers' complaints, and consequent loss of revenue. This condition of affairs rapidly produces a general distrust of the whole field of electric work,—a condition to be deplored, not only from the point of view of the manufacturer or exploiter of electrical apparatus, but also from that of the purchaser, who thus becomes unnecessarily deprived of and disgusted with an agency capable of providing him with light, heat, and power in various convenient forms and methods of application not otherwise available to him.

It would be easy to dilate on the various annoyances and troubles arising from the causes adverted to, but they are so familiar to all who have any experience in this field that it seems unnecessary to do so here. A more important matter would seem to be the pointing out of a remedy for, or rather some preventive measure against, the occurrence of such conditions.

When an electric installation is proposed it is well, if possible, to obtain the services of some one not suspected of having an alliance with any particular manufacturing company, and one who has had practical experience in the direction of the work required, —not selecting a telephone-man, for example, to advise on a question of power-transmission. In past years it has been difficult to obtain competent expert advice outside the staffs of the large manufacturing companies. This is not now the case, however, for some of the best men in the profession are now acting independently of any such connection. But however desirable it may be to procure the best of advice, there are certain points on which some general suggestions may be of value, independently of specific advice relating to particular cases.

It is somewhat difficult to formulate any definite set of questions or points which should be absolutely decided before engaging in an investment of this nature,—an investment which in the end may be not only fairly remunerative, but extremely so. There are, at the same time, as already intimated, certain essential and primary matters needing careful attention before such a desirable result can be anticipated. These are :

1. Cost of real estate.
2. Cost of building.
3. Cost of power (water or steam) plant.
4. Cost of electrical apparatus.
5. Cost of outside construction, to include pole-line and labor on same, wire and stringing same, hanging arc-lamps, and setting converters, if used.
6. Cost of inside wiring.

The first two items depend so largely upon local conditions of price of real estate and building materials that it is scarcely possible to make any intelligible statement in regard to them ; they are further dependent as to their amount on items 3 and 4. These must, therefore, be left in abeyance. Item 3 is also dependent on item 4, which, indeed, must always be the final criterion for the whole plant. It will be necessary to a proper decision of this portion of the subject, therefore, to assume some specific capacity of plant.

Suppose that a certain town should require 50 to 60 arc lights for public uses, and about 1200 incandescent lights for commercial purposes, such as the lighting of stores, hotels, and residences. The cost of the electrical apparatus for such a station, installed complete, including the arc-lamps, should amount to about $4500 for the arc-lighting, and to about $2500 for the incandescent, for high-class apparatus. The steam-plant, not allowing for any considerable increase, but based on the full electrical load—say 150 horse-power—would closely approach the sum of $5000.

The sum allowed for the construction of the outside lines, such as setting poles, stringing wire, hanging the arc-lamps, and placing converters, would vary considerably in different places and under different local conditions. Some general suggestions may be offered, however : For arc circuits about $140 per mile of running wire and running same—using No. 6 B. & S. good weatherproof wire—may be allowed, and for the construction of the pole-line, hauling and setting and gaining poles, placing cross-arms, pins, and insulators, under ordinary conditions, about $160 to $175 per mile is a fair estimate. The primary circuits for an alternating system are dependent on matters other than the mere length of wire used, and in large cities must be calculated carefully and definitely. But in a town of the size under consideration, for the wire and stringing, and the necessary additional cross-arms, pins, etc., assuming that the same poles can be used as for the arc circuits, $1000 should be sufficient. The inside wiring,—that extending from the converters to the lamps,—ought not to exceed, including the lamp and socket, $2.50 per light of 16 candle-power, for plain work. For concealed or special work a larger amount probably would have to be allowed. The cost of converters would be from $1 to $1.50 per 16 candle-power lamp-capacity.

It will thus be found that for a plant of the size suggested, which would not be unsuitable for a town of 5000 to 10,000 inhabitants, the promoters would have to reckon on an expenditure of capital, practically in the form of cash payments, amounting to some $17,000, as follows :

Steam-plant of 150 H.-P., including foundations, stack, piping, belting, etc.	$5,000
Electrical apparatus in station, including arc-lamps, instruments, switch-boards, etc.	7,000
Arc circuit, complete, to include poles, wire, hanging of lamps, etc., on the basis of, say, 8 miles of wire, and 5 miles of pole-line	2,000
Incandescent circuit, primary, utilizing arc-light poles	1,000
Converters for 500-light capacity, leaving balance to be purchased as needed	625
Wiring up, with plain wiring—500 lights—to include lamps and sockets	1,250
Total, excluding real estate and buildings	$16,875

It will be seen that no consideration is here had of the direct-current system for the incandescent lighting. In a town of the character considered, with the direct-current or low-tension system either an impracticably large amount of money for the necessary conductors would have to be expended, or parts of the town area would have to remain without service. The business in such a place is necessarily of a scattered nature, while the low-tension direct system is more especially adapted to localities in which a large and remunerative amount of work can be obtained within a comparatively short distance from the station. This class of work would more properly be considered with reference to the conditions obtaining in a large city.

There are many other considerations in regard to which the central-station manager of a large plant must give careful and anxious thought, such as the kind and quality of fuel, the comparative merits of large or small units of power, the desirability (or the opposite) of direct-coupled dynamos ; these, however, do not properly come within the scope of a few general hints on small stations. The question of the utilization of the plant during daylight by means of a power-service is also one which usually does not arise in connection with these small plants.

It may be thought that the writer is a special advocate of these small electric-lighting stations, but this is not the case ; unless they are designed and laid out with a view to, and capacity for, rapid and easy extension to meet the demands of the future it is the exception to find them remunerative to a high degree. In many cases, however, they serve to obtain possession of a field for business which in growing towns may rapidly become valuable. But too frequently the projectors disregard these considerations, and the above figures indicate rather the amount of money that such stations *do* cost than the amount that a station laid out on proper lines *ought* to cost. At any rate it is hoped that the figures may prove to be of some value,—if not as a guide, then as a warning.

Having estimated the expenditure of capital necessary in the first installation of the plant, the most pertinent matter of enquiry is with regard to the *cost of operation*, as compared with the *total earnings*. It is to be regretted that data of this nature are somewhat reluctantly furnished, but the reason is not hard to understand. Those companies which have been fortunate enough to secure what is colloquially known as a " soft snap " keep their information to themselves to avoid any reduction of the rates that the traffic will bear, while those who have lost money by such an investment do not care to expose what might be considered a want of business acumen.

It is believed that the following figures may be taken as approximately correct, with certain reservations to be adverted to hereafter. Estimates based on general assumptions which are believed to be fair and not unusual will first be given, and certain modifications and corrections to be considered will be dealt with subsequently by way of explanation. The question of revenue is at any rate the more interesting of the two and will be considered first, although it might be thought by some more proper to consider first the cost of operation.

It should be understood that the figure of $85 per annum for arc lights of nominal 2000 candle-power, burning from dark to midnight, is not entirely arbitrary. It is estimated as an average figure under conditions such as those here assumed. Actual prices range all the way from $60 to $200, under varying circumstances :

REVENUE.

Revenue from 50 arc-lamps, lighted each night from dark until midnight, under contract with city at $85 per lamp per year	$4,250
Revenue from incandescent lighting, say *average* load of 500 lamps of 16 C.-P. each, for *average* time of 4 hours per night, taken throughout the year = 2000 lamp-hours per night × 365 = 730,000 lamp-hours per annum, at 1 cent per lamp-hour	7,300
Total	$11,550

OPERATING EXPENSES.

Labor—First engineer	$960	
Second engineer or fireman	600	
Lamp-trimmer and general man	600	$2,160
Fuel (estimated at 750 tons of coal at $2.75)		2,062
Carbons for arc-lamps		500
Incandescent-lamp renewals		600
Taxes and insurance		600
Collections, bookkeeping, stationery, etc		500
Oil and waste		260
Repairs, ordinary		200
Allowance for depreciation (say 7½ % on $12,000)		900
Contingencies and sundries		100
Total		$7,882

Deducting from $11,550 the sum of $7882, we have an apparent profit of $3668, which, as times go, is a very good percentage (about 14½ per cent.) on $25,000, assuming that the total cost of the plant approximates that figure. Now, what are the contingencies which may, and too frequently do, reduce this apparent profit? It will be obvious that these may take the form either of excessive expenditure or of deficient returns.

Excessive expenditure may arise from an excessive consumption of fuel, due to poor quality, careless firing, improper condition of the furnaces or boilers or engines, or of the dynamos or circuits, it being taken for granted that the apparatus was in good condition to start with. A good fireman ought to know how to fire, and if he does not the engineer should show him. Boilers should be cleaned regularly, and engine-valves and all other apparatus overhauled and examined at suitable intervals. Hot boxes should never be allowed. All parts should be kept scrupulously clean, and the circuits kept free from grounds. On the incandescent circuits as few and as large transformers as possible should be used, and also lamps of as high an efficiency as is consistent with a reasonably long life. The current on the arc circuit should not be allowed to exceed the standard, nor should the pressure on the incandescent circuit exceed that required to operate the lamps at their rated voltage to deliver their proper candle-power. Care, or the reverse, in this direction most materially affects the coal-pile. The item of oil, with careless men, frequently assumes alarming proportions.

Large and unnecessary repairs may generally be avoided by foresight in the outset. A little false economy in the installation results in continual repairs to all parts of the plant, from the building itself down to the lamps furnishing the light, not only under the head now being considered, but also by reason of reduced revenues by rebates for defective or interrupted service.

If the lights are extinguished at midnight an economy can be effected in the use of the arc-carbons, the unconsumed portion of the upper carbon (the longer) being often sufficient for another night's run, if used as a lower carbon. The use of double-carbon lamps will also be found desirable in this direction, as one trimming of the lamp often will serve for two nights, especially in the summer, thus either reducing the wages of the trimmer, or enabling him to assist in other work on the lines or around the station.

These considerations should be known to the man in charge of the plant. But too often they are overlooked, and it is poor economy not to have at least one good man in charge, and a matter of \$50 or \$100 a year in the pay of that man may be lost or saved many times over in the course of twelve months. After all, "the best system is the man who runs it."

Deficient returns are due, as to the city arc-lighting, simply to deductions from the bill on account of lamps not burning. A condition of this kind is frequently imposed upon the lighting company, and these deductions not seldom amount to a considerable sum. But if the station apparatus and lines have been installed properly and cared for, there is hardly any excuse for a complete shut-down. The trouble is due usually to careless trimming of some of the lamps, for which the trimmer should be called to account.

Another and more serious difficulty, which applies to incandescent lighting, is that possibly the rate assumed in our table cannot be obtained at all. This may be due simply to prejudice, or to the competition of artificial or natural gas. Kerosene can hardly be considered as a competitor.

The rate of one cent per lamp per hour is the usual standard rate, whether under contract or measured by meter. Sometimes, in making rates, a reduction has to be made for a customer who takes a large number of lights, and in the case of both contract and meter rates a discount is often allowed for prompt payment. Interruptions of service, too, give rise to claims for rebates which cannot always be resisted, though they should invariably be scrutinized with care. The writer remembers a case where a claim was made by a customer that his store was in darkness, and it appeared that he had omitted to turn his switch controlling the lights !

Claims for new incandescent lamps are often made. In such cases stubs of the old lamps should always be returned to the station before new lamps are issued, (1) because the lamp-factories will allow a few cents for each stub, and (2) for the reason that lamps are sometimes stolen and sold, and new lamps claimed to replace them. A customer who *breaks* a lamp should be charged full price, renewals of lamps burnt out being made by the company.

Bad debts are contingencies which must be taken into account in estimating profits. The item of water for the boilers was designedly omitted from the estimate of operating expenses. It should not be a very large one in any event, but, in locating a station, wherever possible advantage will be taken of natural conditions, and it frequently will be practicable to select a situation where water can be obtained for nothing or at a moderate cost by sinking a well, that cost being added to the capital expenditure. If water has to be purchased, the amount must be added to operating expenses.

The cost of coal varies enormously with different localities ; the writer is familiar with lighting-stations where good steam coal is delivered in the station for 70 cents and 80 cents a ton (practically the cost of hauling), while at others $5 and $6 has to be paid. The estimated figures given above must be modified to correspond with the actual price. The high price of coal is usually to some extent compensated for by the fact that in such localities a better price can be obtained for light,—the converse also naturally being true to a degree.

It is possible that some of the figures given might be criticised from the point of view of the best theoretical engineering practice ; here, however, is a condition and not a theory that confronts us, and in the stations now under consideration it would not be practicable to obtain such results as may be arrived at in large installations of possibly several thousand horse-power, fortified with the best expert design, supervision, and attention.

SAND FILTRATION OF DRINKING WATER.

FOR THE REMOVAL OF DISEASE-PRODUCING GERMS.

By George W. Fuller.

THAT danger lies in drinking water contaminated by the waste products of human life has been recognized for many years. The true significance of drinking polluted water, however, has been appreciated by sanitarians only during the past few years, and even now its relation to health is not understood by the general public. In earlier times, under the older theories of the causation of disease, which looked upon the improper mixing of the four internal humors as the basis of all disease, sanitary science found no place. Within the past thirty years, however, there has been established a new theory—the germ theory—of disease, which teaches that many infectious diseases are caused by specific organisms, known as "germs" or micro-organisms. As soon as it was known that the original source of infectious disease existed not *in* us but *around* us, sanitary science became a practical aid to humanity.

The important and rapidly-advancing science of bacteriology has taught us much in regard to the relation of bacteria to our own environment. It is true that bacteria exist in the air, soil, and water, on our persons, and, in fact, nearly everywhere; but it must be clearly understood that only a small percentage of the kinds of bacteria are harmful, just as it is true that only a few of the other and higher forms of vegetable life, such as trees and plants, are poisonous.

One of the most valuable lessons taught by bacteriology is that some disease-germs are able to live in ordinary drinking water for many days. The specific germs of typhoid fever and Asiatic cholera are among those which have been studied most thoroughly, and for this reason they will be used chiefly in the statistics and statements presented in this paper.

The results of numerous experiments by many investigators indicate that the typhoid bacillus is able to live in various drinking waters from three to eighty days. Repeated investigations at the experiment station of the Massachusetts State Board of Health, at

Lawrence, show that this micro-organism is able to live in the water of the Merrimac river at that point for at least three weeks. The duration of life of the cholera-germ in various drinking waters has been observed to be from two days to seven months.

Modern hygiene demands that a drinking water shall be free from disease-producing germs ; and the means by which such water can be obtained are worthy of careful consideration. To obtain a water-supply in the great centers of population from the old-fashioned well is obviously inconvenient, and, moreover, it is unsafe. This fact is due to the contamination of the water by the waste products of human life, as is indicated by the death-rates from those diseases carried by water, in towns and villages drawing their drinking water from wells. In the introduction of public water-supplies the American people have not been slow. Up to this time more than $590,000,000 have been expended in public water-works, water being drawn from more than 2500 sources ; but when it comes to the quality of the water the mortality statistics lead us to the belief that many American water-supplies convey the deadly germs of disease to the confiding consumer. Let us take for example the experience of Chicago. During the year ending September 30, 1892, there were in that city 1790 deaths from typhoid fever. The water during this period was at times seriously infected, and for this reason the tunnels were extended two miles farther from the shores of the lake. Owing largely to this step, in all probability, and to the use of boiled water or spring waters and filters, the number of deaths from this disease during the following year fell to 712, in spite of increasing population and the large number of visitors to the World's Fair. We are shocked when we learn of a railway accident in which a score of persons are killed and as many more seriously injured; but it is a significant fact that less attention is paid to the loss of thousands of lives yearly in this country due to infected drinking waters. Many of these deaths are apparently preventable and, until effective measures are adopted to afford relief, the exisiting conditions will continue to throw discredit on American science, American engineering, and American civilization.

In some localities satisfactory supplies of pure water can be had from driven wells and from surface water taken from water-sheds which are free from human habitation. But it is very rare at the present time that great cities with their large suburban populations can obtain a sufficient quantity of perfectly safe drinking water from either of these sources. It is possible, however, in some cases, to prevent at least to a large extent the entrance of unpurified sewage into a water-supply. The cities of Boston and New York, for example, have water-supplies taken from inhabited water-sheds which are carefully guarded. The table below shows the mortality rates from typhoid fever in Boston during the years 1846–1892. The Cochituate supply was introduced in Boston in 1848, and during the past ten years much has been accomplished towards keeping all sewage out of the water. This has been done in part during the past three years by the filtration of the sewage of Framingham and Marlborough, Massachusetts.

TABLE SHOWING DEATH RATES FROM TYPHOID FEVER IN BOSTON, 1846–1892.

Years.	Deaths per 10,000 Inhabitants.	Years.	Deaths per 10,000 Inhabitants.
1846–49	17.4	1870–74	7.6
1850–54	8.2	1875–79	4.2
1855–59	5.0	1880–84	4.9
1860–64	5.7	1885–89	4.1
1865–69	5.6	1890–92	3.2

While the quality of the Cochituate water at present is reasonably satisfactory, it may be stated in passing that the quantity from present sources will not be sufficient for an indefinite period, and investigations are already under way to provide for the increasing demands of Boston and the neighboring towns and cities.

Many water-supplies drawn from polluted sources have been introduced in America in recent years, apparently in the belief that the dangerous elements were removed from the water on its way to the consumers. It is true that a certain degree of bacterial purification is effected by dilution, by storage in a reservoir holding one or two weeks' supply, and by passage under pressure through miles of iron pipe. These agencies may be sufficient in some cases, but generally speaking these factors of safety are too small ; and the experience of Lowell, Lawrence, Albany, Chicago, and numerous other places, involving the loss of hundreds of lives, shows conclusively that all of these conditions taken together may be insufficient to render an infected water safe at all times for drinking purposes.

At present many cities and towns,—and the number is continually increasing,—are obliged to face the problem, " How can the disease-producing germs be best removed from a polluted water ? " From the results of long-continued investigations, together with the experience of certain European cities, it is now believed that the requirements of modern sanitary science are satisfactorily fulfilled by properly-conducted sand filtration. This method of treating water was first introduced near London by James Simpson in 1839. It is the practice in Europe to pass the water through fields of thoroughly underdrained sand, of from three to five feet in depth. The surface of the sand is kept constantly covered with water. The sediment in the unfiltered water is deposited on and very near the surface of the sand. This gradually increases the resistance to the passage of the water through the sand until a point is reached when the quantity yielded by the filter is so small that it is necessary to scrape the filter,—that is, to remove the upper layers of clogged sand. During the past forty years many filter-plants have been constructed in Europe and numerous improvements have been made in the filtration of water. This has been the case particularly during the past decade, owing to the aid of bacteriology, which enables us to determine readily the efficiency of filtration with regard to the removal of bacteria. The operation of some of the filters is quite satisfactory, as is shown both by low death-rates from those diseases conveyed by drinking water and by the results of numerous bacteriological investigations.

The water from the river Thames, the source of a large part of the London water-supply, was examined bacterially for several years by Professor Percy Frankland before and after filtration. The average results for the years 1886, 1887, and 1888 showed a removal on the average of 97.6 per cent. of the bacteria present in the unfiltered water. The average death-rate from typhoid fever in London during these years was very low,—namely, 1.6 per 10,000 inhabitants.

The operation of the Berlin filters has also been watched closely, particularly at the works near the Stralauer Thor, which were under the direction of Piefke, the eminent engineer. Through the investigations of Piefke and of the bacteriologists of the Hygienic Institute at Berlin our knowledge of the removal of disease-producing germs from water by sand filtration has been much extended.

Massachusetts, earlier than most other American States, found difficulty in obtaining sufficient quantities of pure drinking water, particularly in the case of the larger cities in the eastern part of the State. The two largest rivers of the State are polluted with sewage before they enter from the border, and some of her own streams are also polluted. Under these circumstances the legisla-

LAWRENCE WATER-FILTER, SHOWING EMBANKMENTS.

ture determined to make an inquiry to learn how seriously the water-supplies were polluted, and also what could be done to protect and purify the water. This work was placed in the hands of the State Board of Health, which, since 1887, has systematically examined all of the water-supplies in the State. In 1887 the board established in Lawrence an experiment station, the object of which was to study the problems of the purification of sewage and water under the conditions existing in Massachusetts. The station was designed by Hiram F. Mills, A.M., C.E., who has directed the investigations. During the earlier history of the work attention was devoted chiefly to sewage-purification by intermittent filtration. The fact, however, that typhoid fever has been epidemic from time to time in Lowell, Lawrence, and other Massachusetts cities has more recently given an increased impetus to the study of water-filtration.

In the fall of 1887 a tank six feet deep and 1/200 of an acre in area was filled with mixed coarse and fine sand and a layer of loam six inches thick, the top of which was eight inches below the surface. The total depth of the filtering material was five feet. Water was applied sixteen hours a day to the filter, which was allowed to drain during the rest of the time and the pores of the sand fill with air. Such a filter is known technically as an intermittent filter, in distinction from continuous filters, the surfaces of which are covered constantly with water. The number of bacteria in the effluent was very low, usually below ten per cubic centimeter, and at times it was sterile. In 1891 elaborate preparations were made to determine whether any of the bacteria found in the effluent came down through the filtering material, or whether they had their origin in the underdrains, according to the theory of Bertschinger and other Europeans. The greatest care was taken to prevent contamination of the effluent by air and dust. The average results of 186 bacterial determinations indicated that from May to October, 1891, the applied water which had passed through the reservoir and service-pipes of the Lawrence waterworks contained 175, and the filtered water 4.7, bacteria per cubic centimeter. This was a removal of 97.3 per cent. of the bacteria in the applied water.

To obtain more definite knowledge on the subject river water obtained direct from the canal was applied to the filter, beginning November 13, 1891. Several determinations were made daily of the bacteria in the water, before and after filtration, on the same nutritive medium, cultivated for the same length of time and at the

LAWRENCE WATER-FILTER, SHOWING SURFACE OF FILTER AND THE DISTRIBUTING CONDUITS.

same temperature. The average results from November 13 to December 31, 1891, of 102 bacterial determinations of the filtered water and 88 of the river water, showed that the river water contained 2660 bacteria per cubic centimeter, and the filtered water 0.83,—which was a removal of 99.97 per cent. No relation could be found between the number of bacteria in the effluent and that in the river water, or any influence from the rate at which the water flowed from the filter. Of the 102 determinations, 58 indicated that the filtered water was sterile.

Numerous quantitative determinations of the kinds of bacteria in the unfiltered and filtered water were made. One of the most striking results was that *B. coli communis*, the leading species of bacteria in human feces, and which during November and December, 1891, formed 39 per cent. of the bacteria in the water of the Merrimac river at Lawrence, was not found in the filtered water. Two other prominent kinds of bacteria in the river water were absent in the filtered water ; moreover, the presence in the effluent of the very small number of bacteria was satisfactorily explained by their specific similarity to those bacteria found in the air, the outlet pipe, and the underdrain.

From this evidence it was concluded that with these filtering materials and under these conditions all the bacteria of the Merrimac-river water may be removed by filtration. This filter was continued in operation during the following year, and the degree of bacterial removal remained most satisfactory. The only objection to this filter is the small quantity of water which it will yield. The average rate of filtration has never exceeded 250,000 gallons daily, per acre, and the adoption by cities and towns of filtration through such materials would be very costly. A large amount of attention, therefore, has been devoted at Lawrence to the study of filtering materials coarse enough to filter a municipal supply economically, while removing the disease-producing germs.

Fourteen experimental water-filters were constructed during 1892. The construction and operation of these filters, as well as of the older ones, were such as to throw as much light as possible upon the laws of filtration. Since the removal of bacteria is one of the most important points in the filtration of water, the experiments were arranged so as to allow a direct comparison of the power of removal of bacteria from the water under different rates of filtration, with sands of different degrees of coarseness, with different depths of the same sand, with the presence of loam lay-

LAWRENCE WATER-FILTER, WITH PUMPING-STATION AND GATE-HOUSE.

ers, and with continuous and intermittent filtration. The actual efficiency of the filters was tested by the application of typhoid-fever germs and other important kinds of bacteria, and observations on their passage through the filters. The pure cultures of the micro-organisms were grown in dilute bouillon solutions. Twenty-five or fifty cubic centimeters of these solutions, containing millions of germs, were applied to the filters in a small quantity of water, and the effluent was examined at frequent intervals for several days. Fifty-five such experiments were made during the first five months of 1892, with these average results:

Number of filters tested	11
Number of experiments with typhoid-fever germs	22
Number of experiments with *B. prodigiosus*	19
Number of experiments with *B. coli communis*	14
Average rate of filtration, gallons per acre, daily	1,350,000
Number of bacterial determinations	914
Average number of bacteria per cubic centimeter applied	104,200
Per cent. removed	99 48

[The extreme limits in the rates of filtration in the several experiments were 280,000 and 2,600,000 gallons per acre, daily.]

These experiments were very severe tests upon the efficiency of the filters in removing bacteria, because the number applied was probably greater than would occur in practice, and furthermore the organic matter introduced with the bacteria served them as a food material. The experiments made during the latter portion of the year are much fairer, because the bacteria were applied in small and long-continued doses at frequent intervals, and the food material applied with them did not increase the organic matter in the river water beyond the limits of variation observed from time to time in the amount originally present. The species of bacterium used was *B. prodigiosus*, on account of its easy and reliable differentiation, its similarity to the typhoid-fever germ in its mode of life in Merrimac-river water, and the fact that it has never been found native in this country. In the following table are summarized the average results of daily experiments from September 16 to December 31, 1892:

Number of filters experimented upon	11
Number of bacterial determinations	2,372
Rate of filtration, gallons per acre, daily	1,700,000
Average number of *B. prodigiosus* per cubic centimeter applied	5,700
Per cent. removed	99 87

Daily determinations were made of the ordinary water bacteria

LAWRENCE WATER-FILTER, SHOWING GATE-HOUSE AND UPPER END OF MAIN DISTRIBUTING CONDUIT.

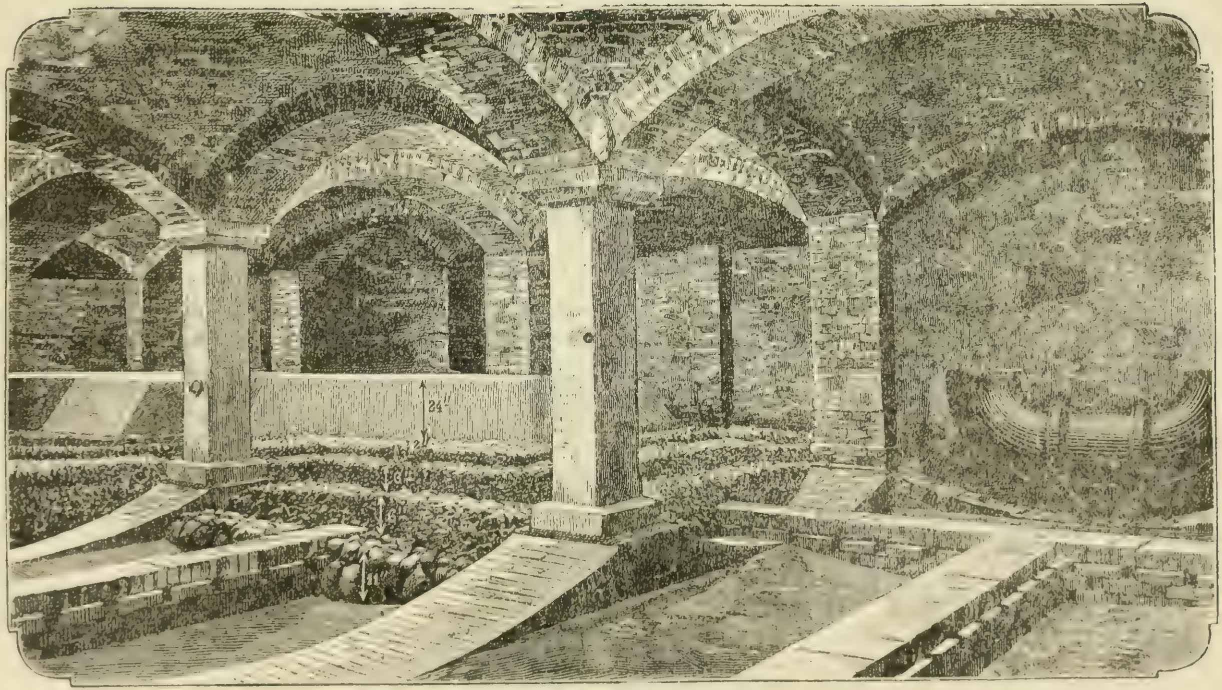
present in the unfiltered and filtered water. It was found that the true degree of bacterial removal was apparently obscured, to a certain extent, by the presence in the water of small numbers of very hardy bacteria which do not appear to come down through the filtering material with the applied water, but seem to have their origin in the underdrains, where they continue to live on the very small amount of food present. The average results of the bacterial determinations of more than 5000 representative samples of unfiltered water and filtered water indicated that the river water contained 8780 bacteria per cubic centimeter, of which 99.21 per cent. were removed by filtration.

As has been stated already, the sediment in the unfiltered water is deposited on and very near the surface of the sand. In time the surface sand becomes so clogged that it is necessary to scrape off $\frac{1}{8}$ to $\frac{1}{4}$ inch. In Berlin it is believed that the efficiency of the filter depends on the scum which is formed at the surface, and in some places in Europe it has been found that the effluent contains as many bacteria just after scraping as the unfiltered water. The efficiency of the experimental filter at Lawrence, under the existing conditions of operation, varies very slightly during the period between scrapings. The average results of 42 scrapings, at times when the conditions of filtration were practically the same before and after the operation, indicated that during the three days before scraping 99.68 per cent. of the water bacteria were removed and 99.45 per cent. during the three days after scraping ; with *B. prodigiosus* these figures became 99.96 and 99.89 per cent., respectively. With filters of coarser sand and higher rates of filtration the effect of scraping probably would become more marked.

It should be stated, however, that it is the upper portion of the filter which largely accomplishes the bacterial purification. This is brought out most clearly by the table below, which shows the number of bacteria per gram found in the sand of a continuous filter which had been in operation from May 2 to October 26, 1892. This filter, nine inches deep, was scraped on October 15 and was again clogged on October 26, the date of examination :

Depth from Surface.	Bacteria per Gram.	Depth from Surface.	Bacteria per Gram.
0—¼ inch	1,100,000	2 inches	21,000
½ inch	320,000	4 inches	4,000
1 inch	140,000	6 inches	1,600

During the past year the city of Lawrence has constructed a



A COVERED FILTER, WATERWORKS OF WARSAW, RUSSIA (AFTER LINDLEY.)

large water-filter which was put in operation September 20. This filter, which was designed by Mr. Hiram F. Mills, is about 2½ acres in area and has a calculated daily capacity of 5,000,000 gallons. The filter is separated from the river by a high embankment made from the material excavated from the site of the filter. The excavation was carried to a depth of seven feet below low water in the river. The filtering sand placed in the excavation was selected with the greatest care ; the general level of the surface of the sand is 2½ feet below low water in the river. The filter is flooded by the water passing through a two-foot gate to an open cement conduit, running the entire length of the filter, at the foot of the embankment ; thence it overflows into shallow distributing conduits which cross nearly the whole width of the filter once in thirty feet.

The bottom of the excavation has cross ridges directly beneath the distributing conduits, and two feet higher than the depressions between. In the depressions, half-way between the tops of the ridges, are open-jointed pipes surrounded with gravel and stones. These pipes extend part way across the bed, once in thirty feet, and conduct the filtered water to a conduit which extends along the land side of the filter and thence to the pump-well. The sand above the ridges is three feet deep and is coarser than the sand above the collecting-pipe, where the depth is five feet. The object of this is to render a uniform flow of water through the filter. When the filter is in operation the water stands about 1½ feet deep over the surface of the sand. The cost of this filter was about $60,000. The chief running expense is the scraping, which means the removal of ⅛ to ¼ inch of clogged sand about once a month on an average. It is necessary to replace the material removed. The operation of this filter,—the first and as yet the only one of its kind in America,—differs from those in Europe chiefly in that it is operated intermittently and the pores of the sand are allowed to fill with air each day. This facilitates oxidation processes and appears to have an advantage over continuous filters, because it removes more of the organic matter which accumulates at the surface of the sand. With regard to the efficiency of this large filter, it may be stated that it removes 98 per cent. of all of the bacteria in the river water and, in addition, it removes a large part of the organic matter by converting it to harmless mineral matter. The removal of this organic matter, the food upon which the bacteria live, aids in causing the 2 per cent. of the bacteria remaining in the filtered water to decrease upon the passage through the reservoir and service-pipes, so that the water as it reaches the consumers contains but one-half of 1 per cent. of the number of bacteria in the river water,—that is, a total removal of 99.5 per cent. The small number of bacteria remaining in the water, moreover, are of a few hardy kinds which are not known to be in any way injurious to health, and leave the strong probability that all disease-producing germs have been removed. It is also gratifying to note that there has been already a marked decrease of typhoid-fever mortality in the city.

The evidence so far presented on the efficiency of filtration is largely of a laboratory nature. Let us now turn to some of the largest cities of the world and compare the number of deaths from typhoid fever, for five years, with the character of the water-supplies in each instance, since drinking water is one of the chief carriers of the germs of this disease. Of the cities mentioned in the table below, Boston and New York have water-supplies taken from inhabited water-sheds, which are so carefully watched that only a relatively small amount of sewage enters either of the supplies. Philadelphia, Chicago, London, and Berlin draw large portions of their drinking water from sources known to be polluted. London and Berlin carefully filter their supplies through sand, while Philadelphia and Chicago do not. Vienna and Glasgow draw their supplies from distant and uncontaminated mountain lakes.

AVERAGE DEATH-RATES AND PERCENTAGES OF TOTAL DEATHS FROM TYPHOID FEVER IN EIGHT LARGE CITIES.

[For the Years 1887–1891, Inclusive.]

City.	Average number of Inhabitants.	Average Number of Total Deaths.	Average Number of Deaths from Typhoid Fever.	Death-Rate from Typhoid Fever per 10,000 inhabt's	Percentage of Typh'd Fever deaths to total deaths.
Boston........	428,580	10,256	170	3.95	1.66
New York .	1,584,546	40,510	384	2.48	0.95
Philadelphia..	1,033,406	21,545	698	6.77	3.24
Chicago.. ...	1,029,200	19,550	843	8 26	4.31
London......	4,139,400	83,440	602 .	1.46	0.72
Berlin (a)....	1,519,400	31,872	196	1.30	0.61
Vienna	806,207	20,332	92	1.15	0.45
Glasgow....	565,710	12 770	100	1.78	0.78

(a) Four years—1887-1890 inclusive.

Knowing the condition of the water-supplies of these cities, this table is very instructive in that it indicates that a great safeguard against typhoid fever is afforded, in the cases of London and Berlin, by filtration. It shows furthermore a point which should not be forgotten, namely, that pure drinking water does not necessarily mean absolute freedom from typhoid fever, because the specific germ may enter the system in milk or other foods and in other ways, as well as by drinking water.

A still more striking illustration of the efficiency of filtration is given by the experience of Hamburg, Altona, and Wandsbeck, with cholera, in 1892. Of these neighboring cities Hamburg and Altona are on the river Elbe. Each draws its water-supply from the river; Hamburg with its intake above the city supplied its citizens with unpurified water; while Altona took its water from the river at a point below the outflow of both the Hamburg and Altona sewers, but filtered its water carefully before using. Wandsbeck secured its water supply from an inland lake and also used sand filtration. Reincke gives the cases and deaths from cholera in these cities, in 1892, as follows:

City.	Population.	Cholera cases per 10,000 Inhabitants.	Cholera deaths per 10,000 Inhabitants.
Hamburg.......	622 530	290	122.8
Altona...........	143,000	40	23 4
Wandsbeck.... ..	20,000	32	21.5

German sanitarians also claim with reason that many and perhaps most of the cases in the latter places were directly imported from Hamburg, and were not due to local causes.

ELECTRICITY IN SUBURBAN DEVELOPMENT.

By Erastus Wiman.

TO those who lift themselves away from political prejudice, and endeavor to comprehend the economic situation in the United States from a purely impartial point of view, there does not seem to be an early prospect for a period of great prosperity or activity. Looking deep down into causes of the present depression, it is evident that there are conditions which are universal and which no legislation will soon remedy,—which no policy will change for a good while to come. An economic revolution extending over a decade, or even longer, may be necessary to restore an equilibrium to the machinery of business, or an activity to enterprise equal to that which has prevailed in the past ten years. Perhaps a war in Europe, pushing up prices of produce to remunerative rates, would restore prosperity to that vast substratum of population, the agricultural class, on whose prosperity all else depends. This class, comprising more than half the population, and those immediately dependent upon it, comprising one-third of the remainder, cannot be legislated into prosperity. Their power to buy and pay rests on prices made abroad, and until, by war or by some great change not now apparently probable, a profit is possible for this wide area of purchasers, all the "politics" in the world will not improve the economic conditions that now prevail.

Under such circumstances it would seem the part of wisdom to attempt a readjustment of affairs to meet the conditions that are likely to prevail. An inventive skill might well find play in the efforts to get around the hard times by plans and modes which in good times might never have been dreamed of. Necessity, that mother which in the past has nourished so many inventions, may now be more fecund than ever, and thus progress, employment, and profit may be possible, where otherwise it would seem difficult to wrest them from the adverse circumstances of the period.

There are two classes in very many localities in the United States now seriously affected by the hard times who could, by a union of interests, materially help each other and promote the general prosperity. Either class, operating upon its own account, is likely to have a slow time of it ; but united both might make substantial, if not rapid, progress. These two classes are the owners of suburban property and the owners of electrical plants. The owners of suburban properties need of all things something to make their holdings accessible, that the demand for homes may be readily met, and their property easily marketed. This can be best done by the second class referred to, namely, the owners of plants now used chiefly at night for lighting purposes, but which might be employed during the day for producing and transmitting energy that would be available for traction on streets at a minimum of cost for construction and operation.

In every town of considerable size in this country there will be found a necessity for expansion ; for, notwithstanding the hard times, babies will be born, young people will marry, and increase of population will go forward. But the great problem to owners of suburban property is how it is to be rendered accessible, and how in these times capital can be induced to build railroads and improve the communication sufficiently to bring property into market. A paralysis has practically set in upon new enterprises which look forward for a reward in the shape of a growth of traffic years hence, and there is little or no prospect for development except at the cost of the landowner himself. He is generally so land-rich and money-poor that this possibility is remote, and the prospect of growth and readiness for the expanding population seem distant.

In the same town, however, like enough, there is an electric-lighting plant that is making only a partial success. True, things have improved a good deal in the last few years, and, after sinking a small fortune in experimenting, there is now a margin of profit perceptible between receipts and expenditure. But with the hard times there is no possible expansion in the business, and with a constant depreciation in this class of property there is no prospect of increased profit without a growth of the town that now seems impossible unless some new effort is made.

These two classes of property-owners do not seem to have much in common,—this suburban burden-carrier on the one hand, and this sanguine but somewhat disappointed and subdued electric-light promoter on the other. Yet each possesses the element that the other needs to develop his interests, and united they can help each other to success and profit.

Hitherto the suburban property-owner has taken all the profit of suburban development by electric roads. While capitalists and electrical promoters have put up the money, borne the risk, and done the work, the owners of land along the line have raked in the "shekels." But this is now no longer possible. The electric promoter has about reached the limit of the capital he can for this purpose control. The banker and the investor are becoming timid regarding new enterprises, and without a very large margin of promise new enterprises, in the shape of suburban expansion particularly, are just now unlikely.

But with a union between all the parties concerned, the advantages of a broad basis for capital are afforded. A united effort, under vigorous and combined management, is possible, and such a division of profit probable that the enterprise would attract attention and invite capital. Thus the large gains which are possible to suburban development, by the transposition from land in acreage to land in lots, would be rendered much more rapid of realization if merged into a deal in which the electric interest participated, or if by a union between them capital was attracted which could now be drawn to neither alone.

Union between the landowner and the electric-light company therefore seems desirable. As the latter is already an organization capable of expansion and of divisibility, it would seem that its powers might be made available. By enlarging or reconstructing it the company could be made an instrumentality large enough to include (1) the light company; (2) the land; and (3) the electric road. The new combination might with propriety be rechristened, —in order to cover and explain its purpose,—as "The Electric, Land, and Railway Company." Into this company could be merged all the interests to be served, and in its bonds, preferred and common stock (as hereafter to be explained) sufficient profit, safety, and attraction might be found for capital, not only locally but from abroad.

It will be asked, What is the prospect for money for these purposes in these hard times? It may be answered that the prospect for money for development of the property and the expansion of electrical enterprises is much more probable by a union of these two interests than by keeping them separate. Both have elements of profit exceedingly potential if united; neither now has any attraction for money, if separated. There is plenty of money,— never was it such a drug as now. For weeks call-money in New York has been at 1 per cent. per annum. There is just as much money in the country as ever there was. It has not been lost in the woods, it is not buried in the earth, nor has it been shipped abroad in ocean greyhounds. This money has got to earn an honest living for the people who own it, just as the electric plant has got to earn a living for its promoter, or the suburban property for its owner. The need of the hour is to bring the three elements together, and that can better be done by a union of the two latter than by any other plan known to those who give most attention to the course of investments, and the projects wherein the greatest elements of profit reside in combination with safety.

It is beyond contradiction that, taking a survey of all classes of investments in the past ten years, no single department of industrial effort has yielded an enhancement of values so great, so universal, and so secure as the profits made by suburban development, aided by electric roads. Starting at Boston, the most conservative of centers, and long ago thought to be practically a completed city, the increase of values created by the expansion of Mr. Henry M. Whitney's West-End street-railway system has been greater than the gain in any other interest. Bank stocks, insurance stocks, railroad bonds, industrial securities, and the thousand other instrumentalities which provide great numbers of Bostonese with bread and butter have barely held their own in the best cases, while in very numerous instances they have declined in values, and some have ceased to yield the harvest even of hope. But the West-End system has not only steadily earned a large return, but steadily enhanced in earning power, while the thrill of life in property along its lines, far out of town, has imparted a new vitality and an enhanced value.

So it is all over the country. In great cities like Rochester, Buffalo, Cleveland, Cincinnati, Chicago, Milwaukee, Atlanta, Omaha, Kansas City, and numerous smaller places the gain in value, the growth in population, the enlargement of area, the stimulation of building, and the general vitality resulting from electric-railway extension is more pronounced, is more secure, and is founded on a better basis than has been created by any other form of investment.

There may have been some exceptions to this general conclusion, and undue expansion ahead of the demand may have resulted in a few instances in loss and delay in return. It would not be surprising if this were so, for, as with other good things in this world, the maxim applies, "The greater the good, the nearer the evil." It may be safely claimed that in proportion to the ground covered, the amount of money spent, the number of undertakings pushed forward, and the social, material, and financial results achieved, no class of investment has been so profitable, and so eminently satisfactory, as electrical-railway suburban development.

With this general conclusion admitted, there ought to be no serious difficulty in numerous minor localities to perpetuate this impression, and steadily realize a similar result. This can best be done in the way herein suggested for smaller places, namely, by a union of an existing organization in the shape of a local electric-light plant and suburban property, the two uniting their advantages to invite the third—local capital—to complete the necessary means of communication, and render readily accessible the property now dormant and dead in realizable value. The property-owner must make up his mind to share with others the enhanced value, as something to which their investment, organization, and experience entitle them. He will make twice as much money in five years by this union as could be made in ten years by isolated and restricted opportunity for realization.

The electric company will also be benefited by an enlarged chance from development, the employment of much that is now idle all the hours of day, and by putting into constant use the forces of organization, expert knowledge, experience, and the manifold advantages which exist in a going concern.

The investor, too, either local or from abroad, will find a ready opportunity for the employment of capital right under the sphere of his own observation. Instead of buying bonds on railroads a thousand miles away, subject to all the chances of competition, crop failures, traffic reduction, and mismanagement, there will be in such local enterprises as are here suggested an opportunity for observation, direction, management, and general interest impossible in far-away undertakings.

It may be asked what one thing more than others would encourage a movement of this character, and give shape and form to this suggestion of a union between electrical plants and suburban development, the two thus united inviting capital. The reply is that legislation has already set in motion the incipient stage of this movement. By a new general law of the State of New York electric-light companies, outside of cities of large class, by a very slight formality may become possessed of all the powers of a railroad company, under which a construction could be carried forward to any point, or in any direction, that public policy permitted. The smallest electric-lighting company in the State can thus be possessed of all the powers enjoyed by the New York Central and Hudson River Railroad Company. With these privileges and powers in hand there are hundreds of towns in which electric-light plants now lying idle all day long could be made available with slight added expense. Even if their capacity had to be doubled they could be made available at far less expenditure than new undertakings, which nowadays are hardly to be thought of.

The New York law as it exists, while it imparts to electric-light and -power companies the privilege of railroad construction and operation, does not contemplate the acquirement of land and its improvement, sale, or lease. This amendment it is proposed now to seek, so that three purposes can be accomplished at one and the same time, namely, (1) the creation of light and power ; (2) the construction and operation of an electrical railroad ; and (3) the acquirement and development of suburban property.

In order that the full scope of the measure may be understood, and that the residents of other States may be informed of what is done and is proposed in New York, the full text of the bill is herewith printed. Being an amendment of a previous act the new bill is somewhat clumsy, but its general purport will be understood :

AN ACT to amend the railroad law, in relation to electric-light and -power corporations becoming railroad corporations.

When all the stockholders of any domestic electric-light and -power company, incorporated under a general law of the State of New York, having not less than five stockholders, and actually carrying on business in this State, shall execute and file in the offices in which its original certificates of incorporation are filed, an amended certificate of incorporation, complying in every other respect than as to the number of signers and directors, who shall be not less than five, with the provisions of the railroad law, and in which certificate the corporate name of such corporation shall be amended by adding before the word "company," in its corporate name, the words "and railroad," or the words "railroad and land" ; such corporation shall have the right to build, maintain, and operate, by electricity as a motive power, a railroad not exceeding twenty miles in length, and such corporation shall otherwise be subject to all the provisions of this chapter, *and have all the powers, rights, and privileges conferred by it upon railroad corporations*, provided that no such corporation shall construct any railroad, which is in whole or in part a street-surface railroad, without complying with the provisions of Article IV of this chapter. Upon filing such certificate such corporation shall also have the right to acquire by gift or voluntary purchase and sale, lands not exceeding two thousand acres, and to hold, improve, lease, and sell the same. This section shall not apply to any railroad now located in whole or in part, or hereafter to be so located, in any city whose population at the last census was 50,000 or more.

Inasmuch as legislatures are now in session in a number of States, it might be desirable for parties in interest to have this law early introduced, and its passage secured for future use. Beyond all doubt its existence will be an incentive to considerable effort in the direction herein suggested. There are literally thousands of towns in different States in which a similar law could be made available for the highest degree of usefulness, development, and increase in value. The existence of such a law makes possible a union of interests now separated and restricted, which, if united, would do more to stimulate activity in expenditure by construction of roads, opening up property, building homes, and generally enhancing values than almost any other piece of legislation now possible.

Enough has been said to set forth the general idea of a possible union between divergent interests for the advantage of many minor localities and individuals. If it is desirable to further discuss it, or if the readers of the Magazine should manifest an interest in the subject, some suggestions of a practical nature could be made as to modes of adjustment between these interests, and plans discussed, as to how the capital can be had, and details as to classes of securities to be created. These would be the result of a good deal of thought and experience in relation to companies now being promoted.

THE FASTEST CRUISER IN THE WORLD.

By Walter M. McFarland, U. S. N.

GREATER interest has been felt in the triple-screw cruiser *Columbia*, from her inception to her recent remarkably successful trial, than in any other of the new ships of the United States navy. Two causes have contributed to this: she was designed to be the fastest cruiser in the world, and a radical change in the disposition of the propelling apparatus was adopted. It has long been the policy of the Navy Department to rely upon fast cruisers, to act as commerce destroyers, for the greater part of our fleet, and the way had been gradually prepared for a vessel like the *Columbia*, which should combine very high speed with great coal endurance, thus putting her more nearly on a par with the "greyhounds" of the merchant service, many of which have bunkers that are veritable coal-mines.

A careful observer of the performances of fast steamships need not be technically educated to notice that high speed and large dimensions go together in vessels intended for anything more than a spurt. The reason for this connection is that the cost of driving the large vessel is less *per ton* than for the smaller ones.

After careful consideration it was decided that the *Columbia*,—then known officially as *Cruiser No. 12* and popularly as "the Pirate,"—should be of about 7400 tons *normal* displacement, 21 knots sustained sea speed, 22 knots maximum speed in smooth water, and about 20,000 horse-power. It may be explained that the term *normal* displacement means what will be about the average displacement in ordinary cruising. With the coal-bunkers completely filled and all stores on board, the *Columbia* will displace about 8650 tons.

With the size and general dimensions of the vessel settled, the problem of the naval architect did not differ greatly from that for any other vessel of about the same size, but the problem for the marine engineer was one requiring special care because of the unusual amount of engine power and the peculiar limitations for the designer of naval machinery.

It has been stated that an increase of size is attended by economy of propulsion *per ton*, but there is an actual increase in the total power required to drive the large vessel, so that it would obviously be a mistake to increase the size beyond actual requirements. In fast merchant steamers the problem is comparatively simple. The vessel is to be driven always at a certain speed and the machinery must be capable of securing this speed with economy and durability. Long experience has shown that to secure these essential features there should be comparatively slow-running engines whose cylinder ratios provide for considerable expansion, and boilers with ample heating- and grate-surface, so that there need be little forcing, while ample weight and space must be allowed.

Naval machinery, on the contrary, has to fulfil two very different conditions. It must be amply powerful to secure the desired maximum speed for comparatively short periods—twelve to twenty hours—and it should work with fair economy at ordinary cruising speeds, which nowadays are about half the maximum, corresponding to about an eighth or a tenth of the maximum power. As has been very cleverly stated by Professor Hollis, of Harvard University, the problem is like that of constructing a man who shall have the appetite of an infant ordinarily, but the stomach capacity of a giant for special occasions. The comparatively small size of naval vessels will not permit either the space or the weight of the merchantman for maximum power, so that recourse is had to forced draft for the boilers, high speeds for the engines, and careful selection of materials with reduced factors of safety. This gives smaller engines and boilers, but they are not so economical.

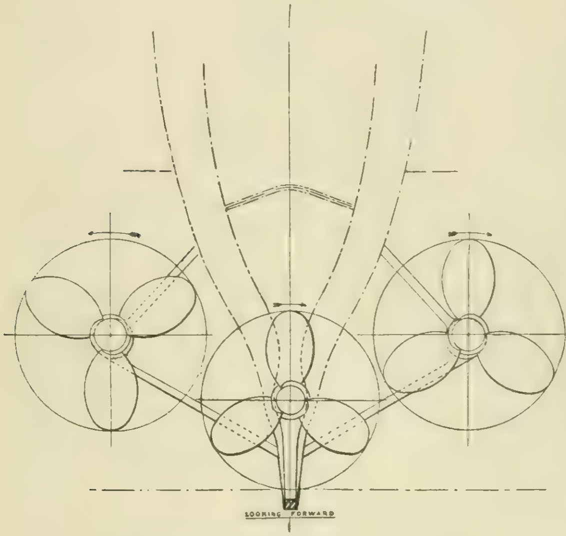
Notwithstanding this reduction of size, the machinery is still enormously too large for economy at low speeds. The undue friction of moving an engine ten times too large will at once be evident, and there are other causes, a discussion of which would be too technical for this article, of greater moment in reducing economy. It is evident, therefore, that some provision must be made for subdividing the engines so that, at low speeds, a portion of them may be thrown out of service, leaving a smaller engine of a size appropriate to the work. Various methods have been adopted to secure this object. In the *New York* there are two engines on each of the twin shafts, and the forward ones can be disconnected, leaving the after ones to do the work at low powers. This plan, however, requires the shafting abaft the after engine to be of the same size as for a single large engine, and it has the disadvantage of doubling the number of parts of the engines and requiring about twice the space and number of attendants necessary when there is only a single engine on the shaft.

Careful study of all the conditions led Engineer-in chief Melville to decide upon the use of triple screws. This plan has the advantage of providing very nicely for a size of engines appropriate to the power desired at several aliquot parts of the total power; it has only one-half more parts than twin screws with a single engine on each shaft; it occupies less room than the plan adopted for the *New York*; the chances against a total breakdown are increased from two to three, while in the *New York* they are no greater than for an ordinary twin-screw ship; the size of the engine for each shaft is less than for a single engine on each of twin shafts; and there is good reason for believing that the economy of propulsion is greater than with twin screws.

The two features which had greatest weight in deciding the adoption of triple screws were the greater economy of using a single engine at low powers, and the reduction in size of parts as compared with twin-screw engines. When a single engine is used the other two shafts are disconnected as far aft as possible and the idle propellers allowed to revolve freely. It requires the expenditure of some power to drag these screws through the water, but this is much less than might be supposed by those who have not investigated the subject, and is much more than offset by the increased economy of one engine of moderate size as compared with two large ones. Twin screws would have required each shaft to transmit about 10,000 horse-power, and, although this is exceeded in some of the large merchant steamers, it is believed to be better practice to keep within this limit. In any case, the smaller shafts are undeniably safer, as the difficulty of assuring the integrity of large forgings increases more rapidly than the size.

The credit of this design is due entirely to Engineer-in-chief Melville. It is the common practice to give the head of an office credit for all that is done, but in this case he not only assumed the responsibility but settled the design, without any suggestions from others except of an adverse nature. Many eminent engineers deprecated the plan as wholly experimental and unwise for the crack ship of the navy. But the plan was not experimental and Melville's credit is deserved for his courage in applying on the largest scale what had already proved a success on a smaller one.

The use of multiple screws is by no means new, dating back to the civil war, where they were used on light-draught boats on the Mississippi called "tin-clads," but the object was merely to secure adequate area of the propeller. They were also used on the Russian circular ironclads called "popoffkas" and the Russian imperial yacht *Livadia*, but as these vessels were failures they cannot be considered precedents. In 1884 the *Tripoli*, of the Italian navy, was laid down, and in her the arrangement of the screws is about the same as in the *Columbia*. About the same time an elaborate series of experiments was carried out in France on a steam-launch fitted with triple screws, and an account of these was published in 1886. The *Tripoli* was tried in 1887 and proved entirely successful. The Italians have also built the *Montebello* and the *Monzambano*, sisters of the *Tripoli*. All of these vessels are small torpedo-gunboats of about 800 tons and 3000 horse-power.



POSITION OF SCREWS IN THE U. S. S. "COLUMBIA."

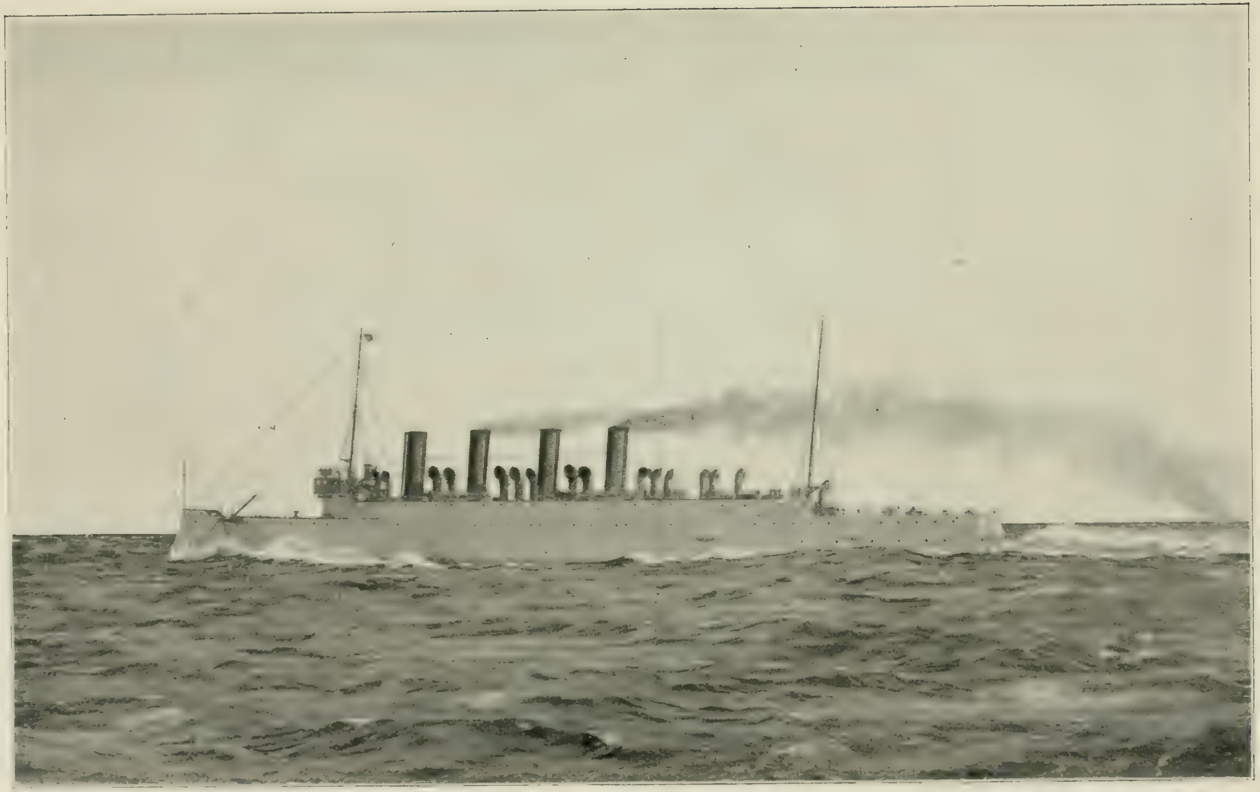
The *Dupuy de Lôme*, of the French navy, was projected in 1887 and began her trials last year, but owing to accidents to the boilers they have not yet been completed. Her displacement is about 6200 tons and her horse-power 14,000,—only two-thirds as great as the *Columbia's*. When the use of triple screws for the latter was decided upon it was not definitely known that they would be used on the former; they had been included in the original design, but statements had appeared that they had been abandoned for twin screws. The French have two battle-ships building which will use triple screws, but their horse-power is only 11,000. The Germans have one triple-screw vessel, the *Kaiserin Augusta*, which participated in the naval review at New York last year. Her displacement is about 6000 tons and her horse-power about 12,000. When the *Columbia* was designed it was not known that this vessel was projected. The arrangement of her screws is different from that of the *Columbia*. It is thus apparent that the *Columbia* is the largest vessel thus far tried with triple screws, while her power is very much greater than that of any other vessel using this system of propulsion.

The *Columbia* is a protected cruiser, which means practically that she has no side-armor, the protection of magazines and machinery being by an armor-deck. This consists of inclined portions at the sides, running from about 4½ feet below the water-line at the sides to about a foot above where they join the horizontal central portion. The inclination is about 30 degrees. The inclined sides are four inches thick and the central part about 2½ inches.

As in all large war-vessels, the under-water portion of the hull is double and minutely subdivided into water-tight compartments. As long as the inner bottom is intact, the outer bottom can withstand a great deal of damage. In fact, everything possible in a vessel of this kind has been done to guard against damage by torpedoes. There is also a central longitudinal bulkhead throughout the machinery space forward of the central engine, and the coal-bunker bulkheads alongside the boilers are water-tight. Numerous athwartship water-tight bulkheads are also fitted, so that, besides the cellular subdivision of the double bottom, the whole interior of the ship partakes of that character.

The battery consists of four 6-inch breech-loading rifles, eight 4-inch rapid-firing breech-loaders, eighteen machine-guns, and six torpedo-tubes. Where the 4-inch and machine guns are placed the ship's side will be armored with 4-inch and 2-inch plates, respectively. The 6-inch guns will be protected by heavy shields attached to the carriages.

For the preservation of the stability by keeping the water-line intact there is a coffer-dam or compartment next to the skin on each side above the protective deck, five feet in width and about seven feet deep, extending the length of the ship. This will be packed with cellulose, which is a water-excluding material. When a shot passes through this it closes and reduces the ingress of water to an inappreciable amount. As the function of the *Columbia* is to act as a commerce-destroyer she has been so designed as to bear some resemblance to a merchant vessel, thus enabling her to get within range before her true character is discovered. She is about 412 feet long, 58 feet beam, 22.5 feet mean draught, and has a displacement of about 7400 tons at that draught.



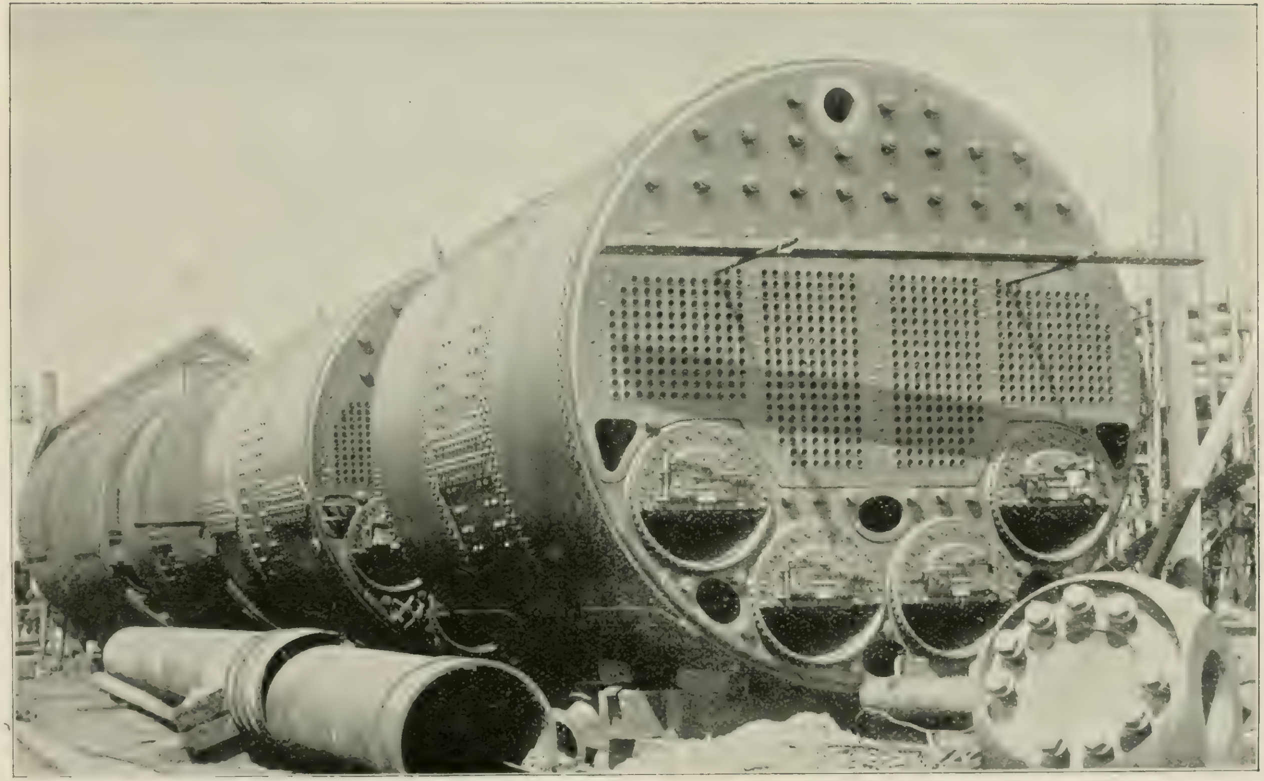
UNITED STATES TRIPLE-SCREW CRUISER "COLUMBIA" AT FULL SPEED.

[Making the World's Record of 22.8 Knots for Four Hours.]

The engines resemble those of fast passenger steamers in being vertical, but have a shorter stroke and run much faster. They are of the now common triple-expansion type. As already explained, each engine, consisting of three cylinders, drives a separate screw. The cylinders are 42, 59, and 92 inches in diameter, each having a 42-inch stroke. The engines are arranged so as to bring the starting gears as near together as possible, although each engine is in a separate water-tight compartment, and this places the high-pressure cylinders of the two forward engines, which drive the side propellers, aft, and that of the after engine forward. The main engines do nothing but drive the screws, all the pumps being independent and driven by special engines. In addition to contributing to smoother working of the main engines, this arrangement has such special advantages in their rapid handling that it is now universal for war-vessels.

Each engine has its own condenser, which is of brass, and cylindrical so as to reduce weight. Each condenser has nearly 4900 brass tubes about 12 feet long, giving a cooling surface of about 9500 square feet. The air-pump attached to each condenser is a fair-sized double engine itself, having two steam-cylinders 16 inches in diameter and two water- or air-cylinders 31 inches in diameter, with a 21-inch stroke. These pumps are almost automatic and give great satisfaction by their steady working and the little attention they require. Each condenser has two circulating-pumps for driving cold water through the tubes. They are of the centrifugal type driven by a single-cylinder engine, and the two can discharge about 14,000 gallons of water per minute from the bilge in case of a leak.

There are eight large and two small boilers, the latter being intended for use as auxiliaries when the vessel is in port. Six of the large boilers are 15 feet 9 inches in diameter and two 15 feet 3 inches, all being 18 feet long. They are fired from both ends, each end having four corrugated furnaces 39 inches in internal diameter and about 6½ feet long. The total grate-surface is 1344, and the total heating-surface 43,264 square feet. When these boilers were designed they were among the largest in the world, although those of the *Campania* are 18 feet in diameter. The plates forming the shells of the large boilers are nearly 1½ inches thick and the seams are treble riveted, the longitudinal joints having a strength of about 80 per cent. of the solid plate. The auxiliary boilers are single-ended, 10 feet diameter, and 8½ feet long, each having two furnaces.



VIEW OF BOILERS FOR U. S. S. "COLUMBIA."

[Diameter, 15 feet 9 inches; length 18 feet; steam-pressure, 160 pounds. Double-ended; four furnaces in each end.]

The boilers are arranged in four groups of two each, and there are four funnels or smoke-pipes,—one to each pair of main boilers. These pipes are about 70 feet high above the grates of the furnaces and $7\frac{1}{2}$ feet in diameter. The compartments which contain the boilers are not only water-tight but air-tight, so as to provide for forced draft by blowing air into the closed space. For this purpose there are sixteen large fans, 5 feet in diameter and 19 inches wide, intended to supply 240,000 cubic feet of air per minute under a pressure of one inch of water (about six-tenths of an ounce per square inch), and to secure the combustion of about 30 pounds of coal per square foot of grate per hour. There are also duplicate feed-pumps in each boiler compartment, one being in reserve in case of accident to the other. These pumps are of the "duplex" pattern, each having two steam-cylinders 12 inches in diameter and two water-cylinders 7 inches in diameter by 12 inches stroke. The main feed-pumps have a combined capacity of about 2000 gallons per minute.

Profiting by the French experiments, the screw-propellers have been placed in the relative positions giving the greatest efficiency. The side propellers, instead of being nearly abreast the rudder as in twin-screw ships, are well forward of this position and distant about 15 feet from the central screw, which occupies the same place as in a vessel with a single screw. In order to avoid any deleterious effect of the race from the side screws upon the central one the side shafts are slightly inclined outwards from a fore and aft position and the central shaft is inclined downwards, with the effect that, on an athwartship plane, the projections of the bounding circles of the screws come clear of each other and the side screws are about four feet higher than the central one. All the screws are three-bladed and have the same pitch, 21.5 feet. The side screws are 15 and the central one 14 feet in diameter. As in all modern screws, the blades are bolted on and adjustable so that the pitch may be altered if, on trial, the first setting is not the best. The screws are made of manganese bronze, a strong and non-corrodible metal, and are carefully smoothed so that the loss from friction may be reduced to a minimum. When it is realized that the tips of the blades pass through the water at a rate of about 35 knots per hour the importance of avoiding friction can be appreciated.

It would require too much space to describe all the auxiliary machinery, for in the modern steamer everything depends upon it,

BOILERS AND THRUST-BEARING AND SURFACE-CONDENSER FOR U. S. S. "COLUMBIA."

—even the absolute essentials, air, water, light, and heat. The use of machinery for distilling and cooling the drinking-water, supplying fresh and removing vitiated air, furnishing electric light and steam heat, has made the modern war-vessel a comfortable home, compared with which the condition of the old sailing-vessels causes a shudder.

The official trial of the *Columbia* occurred on November 18, 1893, and consisted of two runs in opposite directions over a course 43 knots long, off the coast of New England between Cape Ann and Cape Porpoise. The mean of two runs in opposite directions over a short course eliminates the effect of tidal current and gives the true speed, but this is not the case for a long course, so that it is necessary to station observers at short intervals to determine the effect of the tide. The length of the course is chosen so as to require about four hours for the trial, which should not begin until about an hour after the turn of the tide, so as to have the trial completed during one tide and avoid the rapid change in the strength of the current which occurs at both the beginning and the end.

The handling of the vessel and the machinery is done by the contractors and their men, but is under the supervision of naval officers who have control of all the instruments for observing data and who determine whether all the conditions of the contract have been fulfilled. The contract for the *Columbia* required the maintenance of an average speed of 21 knots per hour for four hours, and allowed a premium of $50,000 for each quarter-knot average speed above 21 knots, while there was to be a penalty of like amount for each quarter-knot below that speed. It is evident, therefore, that the contractors have a strong inducement to do everything possible to secure the highest speed. It is supposed by some who are not familiar with the working of powerful machinery at high speeds that it is a very easy matter to earn a high premium. As a matter of fact it requires a combination of circumstances which can only result from perfect design, perfect workmanship, and the highest skill on the part of the men who are running the machinery. The heating of a single journal, the rupture of a pipe, the breaking of a single bolt, and other trifling mishaps to a single part may make all the difference between premium and penalty, and when it is remembered that there are hundreds of such parts, each of which must be perfectly adjusted and looked after with unceasing vigilance, it is seen that the carrying through of a successful trial and the earning of a premium requires great skill and experience. No contractor dreams of making the official trial until several preliminary ones have shown that everything is in perfect adjustment.

On the official trial the *Columbia* maintained an average speed of 22.8 knots, equal to about 26¼ statute miles. The steam pressure in the boilers was 147 pounds and the revolutions of the screws 134, 127.7, and 132.9 per minute for the starboard, central, and port screws, respectively. The temperature in the engine-rooms averaged 85° and in the fire-rooms 106°. The horse-power of the main engines and auxiliaries was 18,500.

It has been stated that there is reason to believe that three screws are more efficient than two, and this is based on the horse-power required in the *Columbia* as compared with that for other recent ships driven by twin screws. The *New York* furnishes an excellent example, because her hull and machinery were designed by the Navy Department, like those of the *Columbia*, and the same eminent firm built both vessels, so that in each case there was perfection of workmanship and of skill in running the trials. The *Columbia's* model is slightly more favorable for speed, but the talented designers of the Bureau of Construction always give the best lines for speed that the dimensions will permit. The *New York* was about a thousand tons larger on trial than the *Columbia*, but by means of what is known as "Froude's law of comparison" it is possible to determine the speed and power for a vessel of different displacement but where the power per ton will be the same as in the vessel actually tried. In this way we can find what the powers would be for the same speed in a vessel of any given size when driven with the efficiency which obtained in each vessel actually tried. Making the calculation for a vessel of 10,000 tons displacement, it is found that at a speed of about 24 knots the triple screws would have a superiority of about 10 per cent. It would not be fair, from a single comparison, to claim this figure as general, but it shows clearly that there is an increased efficiency.

The *Columbia's* speed of 22.8 knots per hour for four hours is the highest accurate speed for such a period ever attained by any large vessel, but it may be mentioned that the speed was also measured by two "patent logs" of the best type, and the mean of their readings gave a speed of 24.34 knots. Patent logs do not give accurate results, but the record still has a value because the speeds of British war-vessels, with which our own are constantly compared, are obtained in that way, so that in such comparisons the *Columbia's* speed should be taken as 24.34 knots. This figure is far above the similar record of any other large vessel.

A comparison is naturally invited between the performance of the *Columbia* and that of the fast transatlantic liners, and statements have appeared attempting to discredit her in advance of her trial because her sea speed had been guaranteed at 21 knots, while the *Campania* and the *Lucania* are credited with over 22 knots, the latter being given a record of 22½ knots for twenty-five hours. Inasmuch as the *Columbia* has a *real* speed of 22 8 knots *at sea*, she has beaten the *Lucania*, and the sea was not a mill pond by any means, as the trial was made on the day after a heavy blow. There is, however, a very important point to be noticed in connection with the *Lucania's* speed. The speed given her is based on her noon positions on consecutive days *with no allowance for current*, which in fact could not be determined accurately under the circumstances. Now it is a curious fact that the phenomenal single-day records of these fast ships are always made when coming westward, and nearly always when in about the same part of the course. It is well known that on the westward run, for a distance equal to about two days' steaming, there is a favorable current which, at times, is equal to a knot per hour. While the *Lucania* may not have had the benefit of the full strength of this current, she undoubtedly did profit by it, and this must be remembered when comparing her speed with the *Columbia's*, which is the actual speed through the water without any assistance from current.

Great credit should be given to the builders of the *Columbia*, the William Cramp & Sons Ship and Engine Building Company of Philadelphia, for the splendid work they have put upon this vessel as well as the others they have recently constructed for the navy.

* NOTE.—The illustrations accompanying this article are made from photographs kindly furnished by Messrs. Cramp & Sons.

THE JOPLIN ZINC-MINING DISTRICT.

By Hamilton S. Wicks.

IT has been said of the State of Missouri that, if walled in so as to prevent all communication with the outside world, she would be able to exist independently from the production of her own soil and mines. The State is indeed a nation in itself, when one considers the variety and amplitude of its resources. The soil and climate are most favorable, the natural transportation facilities are unsurpassed, and valuable ores, coal, building stones, and clays abound. The annual value of surplus commodities produced within the State, and marketed by rail or river, exceeds $125,000,000, as shown by the returns of the transportation companies. Among these surplus commodities the item of zinc deserves special mention, for the reason that the State is now producing at the rate of fully two-thirds of the yield of the whole country, and more than one seventh of the world's production. The Missouri product of spelter in 1893 reached 53,636 tons (of 2000 pounds), while the total production of the United States was 80,454 tons. Nearly all of Missouri's yield of zinc comes from the Joplin district, in the extreme southwestern portion of the State. The zinc-fields extend into southeastern Kansas, and embrace an area of sixty by thirty miles ; yet the great bulk of the production comes from a rich district within a radius of ten miles from the city of Joplin as a center. The spelter turned out of the furnaces of Illinois, Missouri, and Kansas all comes from the ores of the Joplin district, while the spelter from furnaces in the east and south is made from other ores.

The discovery of zinc-blende in this region was made about twenty-three years ago, in connection with the lead-mines opened by Moffet and Sargent in a creek-bottom now embraced within the limits of the city of Joplin. From the beginning the production has increased steadily, and although the crude methods of mining and treating the ores still prevail to a great extent, they are in many instances being supplanted by modern appliances, and the prospective importance of the region is such that the attention of the whole world interested in zinc and zinc-mining has been forced to it. This region may seem very remote and inaccessible to the

GROUP OF ZINC-MINING PLANTS ON THE "THOUSAND ACRE TRACT," JOPLIN, MO.

people of the eastern States and of Europe, but it will appear less so when it is stated that the center of the district is traversed by four important lines of railway—the Missouri Pacific, the Atchison, Topeka, and Santa Fé, the Kansas City, Pittsburgh, and Gulf, and the Kansas City, Fort Scott, and Memphis—and that the population which has been attracted to this section is supplied with most of the conveniences of modern civilization. The city of Joplin is barely twenty-three hours from Chicago and only fourteen hours from St. Louis.

The entrance to this zinc region is made abruptly at Webb City, Missouri, and Galena, Kansas,—the outlying portals to the Joplin district. Up to the very moment of entering either of these camps there is no suggestion of mines in the whole landscape. There are no mountains here, the Ozarks being many miles further east. Even the foot-hills begin in the adjoining county of Lawrence, in Missouri. The country here is gently undulating, and well-cultivated fields of grain, interspersed with patches of timber, conceal the rich deposits of mineral. At Webb City and Galena, however, all is changed as if by magic, and the rough, coarse underside is exposed. The view presented to the traveler on every side is of innumerable piles of white flint rock of pyramidal shape, varying in height from ten to fifty feet. Above, around, and among these piles extend long lines of wooden "flumes," while towering above the whole is an interminable array of shaft-houses, hoister-derricks, and smokestacks. It is altogether the liveliest picture presented by any mining camp outside of the silver and gold regions of the Rocky mountains. A closer inspection of this chaotic assemblage of flint dump piles will reveal behind every heap a shaft sunk into the earth, from which the crude ore with the gangue rock is being hoisted to the surface,—in some cases with the aid of steam or electricity, and in others by the original method of operation by horse-power.

UNDERGROUND VIEW IN A JOPLIN ZINC-MINE.

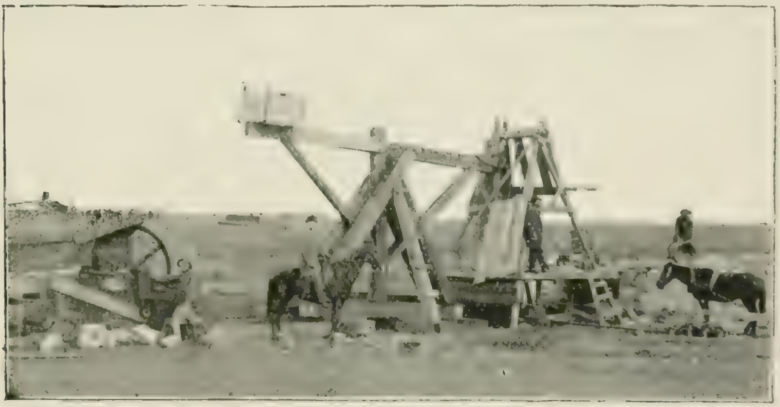
The first car load of this material was tested at the zinc-works at La Salle, Illinois, where it was found to be zinc-ore of a high grade. But the twenty tons embraced in this shipment returned only $15 net, or 75 cents per ton. Shortly after, $3 per ton was offered, with an early advance to $7 or $8 per ton. A record of the amounts sold from the Joplin district and the prices paid during the period between the years 1873 and 1893 has just been compiled by J. R. Holibaugh, M. E., from which it appears that 960 tons of zinc-ore were sold during 1873, at an average price of $9 per ton, bringing in a total of $8640. The rate of output and the proceeds per ton increased steadily during the next ten years, the

PRIMITIVE HORSE-HOISTER IN JOPLIN DISTRICT.

figures for 1883 being 52,200 tons at an average price of $16.90, or a total of $882,218. During the past ten years the same steady increase in the amount and value of ore has been recorded, with some fluctuation recently owing to the financial stringency prevailing throughout the country. The production for 1893 reached 134,090 tons of ore, at an average price of $19.25, or a total of $2,581,232. The total output for the twenty-one years has aggregated 1,265,119 tons, representing a value of $26,781,580. It is fair to assume that with the return of prosperous business conditions generally, and with the new uses for zinc in commerce which now seem near of realization, the production will be very greatly augmented in this district during the next decade.

The deposits of zinc ore in the Joplin district occur in chambers apparently along subterranean waterways, at a depth averaging from 60 to 170 feet, as at present mined. But millions of dollars' worth have been taken out at a shallower depth, and it is expected that much more will be mined at a greater depth. The ore is found in conjunction with broken-up flint rock, to which it is cemented or through which it is disseminated. The country rock is Keokuk limestone. Geologically the district is sub-carboniferous. Deposits of lead are found nearer the surface and the zinc underneath, although more frequently the ores are mingled indiscriminately in a conglomerate mass of limestone, chert rock, delomite slate, pyrites, shales, and calcite.

The system of developing lead- and zinc-mines in Missouri is an outgrowth from the necessities of the situation. An old miner once said to me: "This country has been built up by ignorance and poverty; ignorance brought us here, and poverty kept us here." There was little capital at first, and less machinery, but an abundance of muscle and brawn, so that the lease and royalty system early found favor. The system is founded on the supposition that a man's time here is worth nothing unless he strikes "jack"—the local name for zinc-ore—and then it is worth exactly what the "jack" is worth, after deducting all expenses and paying the royalty. The landowner leases his land, commonly in forty-acre tracts, to a company or an individual, on a royalty from 10 to 22½ per cent. of the value of the zinc-ores mined, and 20 to 40 per cent. of the value of the lead-ores mined. These mining leases run usually for ten years. A shaft is sunk for ore, and when it is found in paying quantity one of the prospecting shafts is put down to a sufficient depth to drain the property. The miner hoists, crushes, and washes his ore on the ground, and sells it to agents of various smelters located in different parts of the country. Money for all ores passes through the hands of the landowners. They retain the royalty due to themselves and the miner receives the balance, out of which he pays all the expenses of mining, crushing, cleaning, and hauling. The system of sub-leasing small parcels of land to actual miners prevails to a large extent. Parties who have leased forty acres or



CORNISH PUMP IN GENERAL USE IN THE JOPLIN DISTRICT.

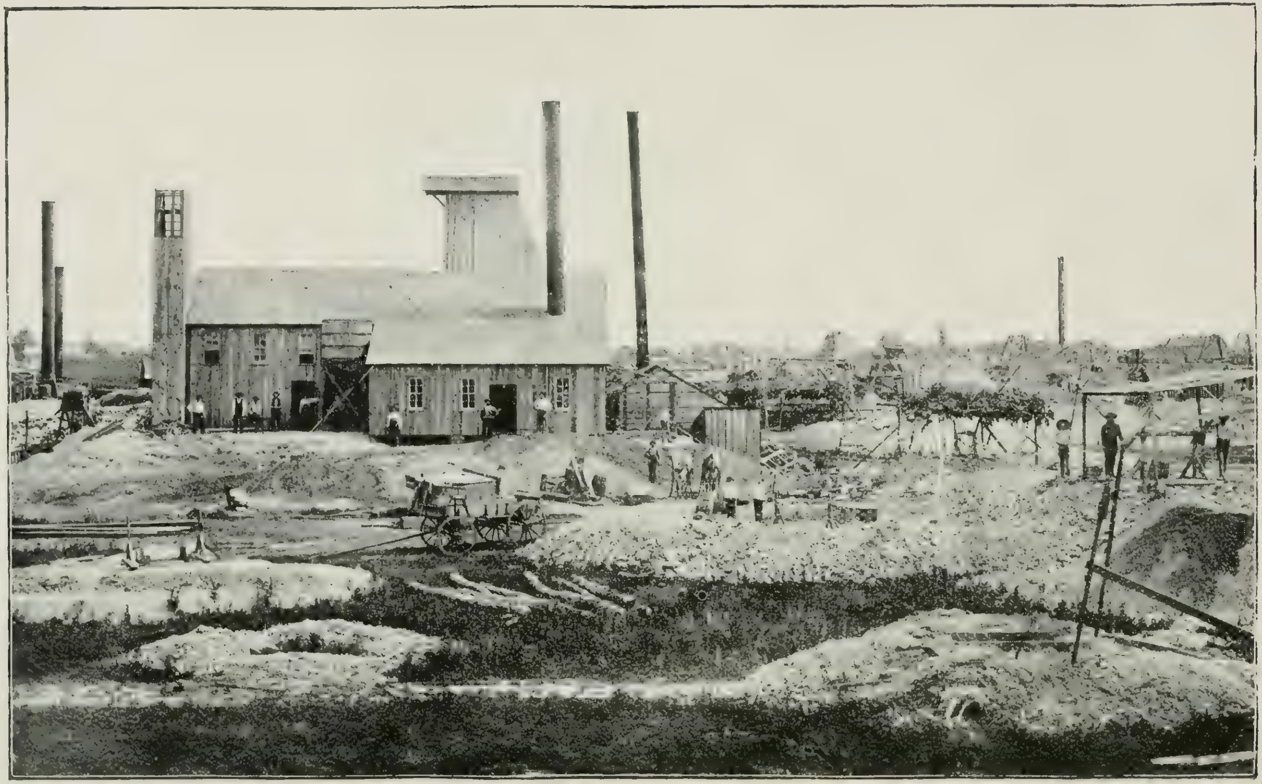
HAND-JIGGING AT A JOPLIN ZINC-MINE.

more lay off the land into miners' lots 200 feet square, which they sub lease to actual miners on a royalty of 20 per cent. or more. When a miner is not successful in finding paying ore or when, owing to the want of capital to provide proper machinery, the ores are too poor to be profitably hoisted and cleaned by hand, he stops work and forfeits his lot,—usually at the expiration of ten days. Many shafts that are sunk for ore prove a disappointment. Drill-holes are frequently put down that strike nothing but lime and flint. Even some that indicate ore fail to show any when the shaft is sunk. There are failures and successes in zinc-min-

SACKING ORE FOR SHIPMENT TO EUROPE.

ing as in every other kind of business. Much depends on the exercise of good, practical, common sense.

These mining leases compel the miners to work continuously and to crib and timber in good, workmanlike manner. Some of the miners, endowed with more business sagacity than others, have become able to invest in machinery to hoist and dress their ore, and these have in time become capitalists with fortunes of from $50,000 to $200,000. Still others have become very wealthy, owning large tracts of land and profitable mines, the builders of



"SUCKER FLAT" (JOPLIN, MO.), SHOWING THE NOBLE MILL AND GENERAL MINING.

handsome business houses in Joplin and neighboring towns, and the possessors of handsome residences.

At Galena, Kansas, the school-board erected a handsome building from the 10-per-cent. royalty received from mining on one of the school lots, and a church there pays the pastor's salary and keeps the church in repair from the royalty from mining on the church's ground. Shaft No. 1 on the Allen land, near Joplin, has produced over $100,000. The Richland Mining Company have extracted from two lots $109,144. The Ealer land (forty acres) of Carterville has yielded fully $400,000. The Perry forty has yielded since June, 1892, $76,196. The production of the Tracy mines aggregates $1,000,000. The pump-shaft of the Cohinore mine, within the limits of Joplin, has averaged 200 tons of rough ore per week for the past two years. The two celebrated Poundstone lots in Carterville have turned out over $750,000 worth of ore, and the ore is not yet exhausted. The Southside mines of Galena have yielded over $2,000,000, and the Center Creek mines have yielded over $4,000,000. This list might be extended to a great length.

Three miles southeast of Joplin in September, 1891, the Rex Mining and Smelting Company put down a drill on their "thousand-acre tract," striking zinc at a depth of forty-five feet. Other drill-holes were sunk in quick succession, with the result that there was a rush of outside miners anxious to make leases at a royalty of 20 per cent. The output of ore increased steadily until "high-water mark" was reached during the week ending November 25, 1893, when the product was 864,030 pounds of zinc-blende and 36,290 pounds of lead. The entire production of this tract which, by the way, was mined from less than a hundred acres of the ground, had reached at the date named more than 10,500,000 pounds of zinc-blende and 1,750,000 pounds of lead, selling altogether for $400,000.

A thirty-acre tract of land located in the suburbs of Webb City and known as "Sucker Flat" is said to have derived its name from the Hon. John W. Noble, the secretary of the interior in President Harrison's cabinet, who was the supposed "sucker" in the case. In 1888 some over-shrewd parties induced Mr. Noble, then an attorney in St. Louis, to pay $500 for four acres, under the representation that it was good mineral land. As soon as the money was paid the parties interested, with a general guffaw, designated the property as "Sucker Flat." Soon the original owners attempted to recover the land by paying double the price for it, but the laugh was now on them, while Mr. Noble came to be regarded as unusually keen at a bargain. As prospecting continued to reveal the character of that section he was offered $12,000 for his little purchase, but he has already collected much more than that in royalties from the ores mined from his four acres, which continue to be large producers. The total production for what is still called "Sucker Flat," including the ten acres of the Center Creek Mining Company, reaches to date $1,250,000.

Not far from Joplin is a twenty-acre tract of ground which four years ago was practically unknown to miners, and the owner, a lady in an Indiana village, doubtless would have accepted $10 an acre for it. Zinc-ore was accidentally discovered on this tract in 1890, and in three years the production had aggregated $300,000. The picture entitled "Sacking Ore for European Shipment" represents a view on Mrs. Allen's land when a shipment was being made to Messrs. Vivian & Son, at Swansea, Wales, of 1000 tons of zinc-ore, assaying 60 per cent. and better. The price paid for the ore averaged $24 per ton net to the producer.

A visitor to one of the zinc-mines in this region may be invited to go down a shaft offering nothing but a dirty tub as a means of descent. Into this one foot is thrust, while the other is used to guide the tub, to keep it from catching on the timbers which line the shaft. At a depth of say a hundred feet the tub comes to a stop, at the mouth of the drift in which miners are at work extracting ore. Below this point in the shaft is the "sump," which, until the visitor's eyes adjust themselves to the darkness, may be imagined to be bottomless, though only ten or fifteen feet in depth. Once in the low and narrow drift one walks as much as possible upon the rails of a little tramway which conveys the ore from the head of the drift to the shaft. The passage-way is usually dripping and muddy, and one needs the protection of a rubber coat and boots which may be borrowed from an accommodating miner. The drifts of the mines in this region extend from 100 to 500 feet, and one soon reaches the end where the brawny miners are working with pick and shovel. As the lights are held close to the wall of the drift, it does not require an expert to detect the glittering crystals of zinc-blende and lead, intermingled with the flint rock and the limestone. The theory of geologists that the zinc-blende was deposited by metalliferous waters coming up through crevasses and veins, and spreading out through these beds of broken flint and lime, seems verified by the fact that miners' tools left in old mines have been found long afterward covered with zinc crystals, formed from the waters that have dripped on them. Analyses of water here have shown thirteen grains of zinc per gallon of 231 cubic inches.

As before intimated, the primitive methods of hoisting the ores do not prevail in all the shafts; nor does the hand jig serve in all cases for handling the ore after it reaches the surface, although it is still largely in use. The hand jig, as shown in one of the engravings, consist of a wooden plank box, six feet square and three feet high, which is nearly filled with water. Into this is hung a sieve-box, two by five feet, and eight inches deep, to which is attached a pole about sixteen feet long. The miner, seizing the end of this pole and raising his hands as high as possible above his head, jumps up and down rapidly, giving a sharp, jerky motion to the pole, thus agitating violently the contents of the sieve. The sieve is filled with crude ore direct from the mine after it has passed through a simple Blake crusher and a pair of Cornish rolls. The process of jigging causes the heavy ore to settle to the bottom of the sieve-box, when the lighter ore is shovelled off to the waste-pile. One good man operating a cleaning-jig will be able to turn out 1½ tons of clean ore in a shift of nine hours.

Of late several steam concentrating-plants have been erected. The ore is run by an elevated tramway directly from the mining-shaft into the mill, where it is dumped upon a large platform and at once shovelled into the crusher, only the larger pieces of chert rock being culled from the general mass. Practically everything hoisted goes through the crusher and Cornish rolls without previous treatment. From the crusher and rolls the crushed stuff is conveyed to a revolving screen and thence to the steam jigs, which consist usually of five "roughers" and six "cleaners." The principle of operation of the steam jigs is the same as that of the hand jigs. The rough ore crushed and screened is made to flow with a sufficient volume of water over the jig sieves, which are rapidly agitated by plungers attached to an eccentric shaft operated by steam-power. The heavy ore is carried to the bottom by gravity, while the light stuff remaining on top is washed off into the "tailings." These jig-boxes are tapped at the bottom at intervals and the cleaned ore taken to the bins. The common concentrating-plant of this region, while running on 10-per-cent. "dirt," will clean seventy-five tons in two ten-hour shifts, placing 7½ tons of cleaned ore in the bin. These plants cost about $10,000 and the cost of operation does not exceed $30 a day. The rough ore from the mines will average about 10 per cent. of zinc-blende throughout the district, although the dirt from many mines yield fully 25 per cent. The assayed value of metallic zinc in this ore runs from 57 to 62 per cent. Of this metallic content 80 per cent. is saved by smelting in the ordinary Belgian furnace. The cost of mining will average very nearly $10 per ton throughout the district. The cost of smelting varies from $8 to $10 per ton. When the zinc-ore has been smelted it enters the market as spelter, containing on an average less than 2 per cent. of foreign substance.

The mining of zinc as practiced in the Joplin district is a most fascinating business. The results are so immediate and so apparent that the most inexperienced person can readily comprehend them. The slight depth at which ore is struck and the simple methods which can be made available mark a great contrast when measured by the deep mining of Nevada and Colorado, with their ponderous pumps and crushers and complicated stamp-mills and concentrating machinery. Not only is the return very great, compared to the amount of effort expended, but the result is permanent, the output of a given shaft lasting perhaps for years. Zinc-mining is an industry with a yield as certain and steady as the corn or wheat crop, with the advantage that a new crop is gathered weekly instead of once a year, and that it is practically in shape of actual money injected into the channels of commerce in this vicinity. It is so nearly like getting something for nothing as to afford a fascination,—or, in colloquial phrase, a "mineral fever," —which will catch a millionaire as quickly as it will a poor man.

The principal use which has been found in America has been for galvanizing iron as a protection against rust. Its utility in this connection is so manifest that it is used to galvanize not only all sorts of architectural iron-work, but also barb-wire, which it renders threefold more lasting. It is also largely used in manufacturing brass. The increasing use of electricity has increased the consumption of zinc in a large degree. It is used in desilverizing processes, in lithography, and for glazing paper. It is used in the making of domestic utensils, toys, buttons, packing-cases, stamped work, refrigerators, for sheeting vessels, and a multitude of other purposes. In Europe zinc finds its most general consumption as a roofing material, for which it is especially adapted. It would seem an easy matter, to find favor for zinc for this purpose in the United States.

OFFICIAL ARCHITECTURE IN AMERICA.

By Montgomery Schuyler.

IT is perhaps as much a political as an esthetic reflection that, while public architecture in every other country fairly represents the best that the architects can do, in the United States it is very apt to represent the worst. There is at any rate no doubt about the fact. The professional goal of a practitioner of architecture in France—the goal which he sets before himself even at the beginning of his studies, and to which his studies are largely directed—is an appointment to be a government architect. The centralized system of administration that survives all political changes makes the public architecture an official function. Not only would the notion of employing an obscure architect to design a public building be resented by the public, but the execution of such a notion would be quite impossible. An architect must prove his ability according to the tests imposed by a professional education which is itself the care of the State, and also in private practice, before he can be so much as considered when there is a question of designing an important public building. The result is that, whatever may be thought of a new public building in Paris or in the provinces, there is never any doubt that it represents what the official hierarchy and the public alike consider the acme of professional attainment. Throughout continental Europe the rule is the same. In the British islands, where the popular agreement that the arts will flourish best if the government leaves them alone is largely the expression of a popular indifference whether they flourish or not, it is still true that the public architecture represents the best that the architects can do. From the time of Sir Christopher Wren to that of Sir Gilbert Scott the architects who have stood highest with the cultivated part of the public have been the architects chosen to do the government work.

Westminster Palace is not an object of unmixed national pride, but Sir Charles Barry was at the head of the profession when it was designed, and, although in the light of what has been learned and done since it is rather a queer example of secular Gothic, it embodies as much of Gothic as was understood at that time among the leading architects who resented and resisted the revival that was really imposed upon the profession by the public, and of which the origin was in part archæological and in part ecclesiological.

Undoubtedly the Gothic revival is not seen at its best in public buildings. It was begun by the Houses of Parliament, and it may be said to have been definitely closed, so far as secular work goes, by the erection of the Law Courts. The world is pretty well agreed that this latter building is a failure, both practically and artistically, and yet it was certainly not a failure for lack of pains,—of far more pains than have ever been taken to secure in America a work of official architecture that should be the best that the architects could do. The competition for the Law Courts was a model of liberality and consideration. The invited competitors were the architects most in view, and the architect finally chosen was one of the most eminent of these. Moreover, it was one of the most interesting architectural competitions that has ever been held, and Mr. Burgess's design was probably the very finest achievement of the Gothic revival, and had more influence upon the practice of his contemporaries than any modern building actually erected in England, having very evidently supplied the architectural motive for buildings on both sides of the Atlantic. It is noteworthy, however, that Lord Palmerston actually interposed to dictate the style of a public building, against the protest of its architect, and insisted that he would not have Gothic, but would have "something light and airy." It would have been out of the question for such a question to be decided in any other country than England, always excepting our own, by a layman's freak, and this official freak was especially deplorable because Sir Gilbert Scott, if he had been left to his own devices in the design of the Foreign Office, might very possibly have produced a more worthy monument of the Gothic revival than any that it has left in the shape of a public building. Since the close of the Gothic revival no public building of the first importance has been erected in England.

If such a building were projected, however, an attempt would be made, we may be sure, to make it worthy of the best that the nation could do. There would not be that complete indifference whether it was good or bad that characterizes our own productions in this kind. Undoubtedly during the past quarter of a century the government of the United States has erected more buildings for its own use than the government of any other country in the world. It has spent more money upon architecture and got less architecture for its money than any nation of past or present times. The waste is appalling when we come to think what might have been done with this money if the standard of official architecture had been kept up to the standard even of the best private building. If we had had a bureau of public works with a succession of able and responsible architects at the head of it, it would have had by this time a tradition of its own that would have been of immense value to the architecture of the country. For the national building in any town is sure to be a conspicuous building. With the system now firmly established in Congress of log-rolling for building appropriations, and of erecting in villages public buildings suitable, in scale and cost, for the cities these villages are expected to become, it is apt to be the most conspicuous building, and the pioneer and model of edifices built of permanent materials. And what models they have been, these public buildings, from the time of Mullett and earlier! With one or two distinguished exceptions the supervising architects have not been men of high professional standing, although they have been quite as eminent as could have been expected from the conditions of their service. Indeed, the status of the supervising architect is a measure of the legislative, and consequently of the popular, appreciation of architecture. That functionary has the spending of far more money than any private practitioner. He has the supervision of ten times as much work as any conscientious private practitioner would consent to be responsible for. Yet his status is that of a clerk and his compensation such as would not tempt an established practitioner, unless such a practitioner were sustained by professional enthusiasm and willing to make sacrifices for his art. Even so his sacrifice would be vain. A busy architect in private practice has far too little time to devote to the art of architecture. The supervising architect of the treasury, if he discharges the responsibilities his office imposes upon him in other respects, can have none at all.

The increase of these responsibilities with the increase of the public building has put it quite out of the question that the supervising architect could, in any proper sense, design any of the buildings he is directed to erect. This was the sufficient motive and justification of the bill providing for the opening of the design of public buildings to competition, a bill to which many architects, having the honor of their profession and the architectural credit of the government at heart, devoted much unselfish labor. But the measure was shorn of nearly all its purpose and effect by the amendment that was foisted upon it, forbidding the secretary of the treasury to pay for the services of any of the architects whom he was authorized to select as competitors, except the architect whose design was chosen for execution. Nothing could show a more complete misapprehension of the purpose of the bill than this amendment. It is true that the architects at large are responsible for this misapprehension. So long as men who call themselves architects can be got to do work for nothing and submit their designs as chances in a lottery, so long will men who are unaware that there are architects and architects, and that the work of some is more desirable than the work of others, be unwilling to pay for what it seems to them they can get for nothing. Architects of repute will sometimes consent, whether or not they are well-advised in consenting, to enter open competition for public works, when they are assured of competent judgment upon their designs, and when the prizes are numerous enough and large enough to give a reasonable chance that they may be reimbursed for their actual outlay. But it is perfectly well known to private builders that architects of repute will not submit their designs to lay judgment unless they are paid for preparing them. What the government of the United States refuses to do every corporation that projects a new office-building, and that desires to have a choice of designs, finds it necessary to do. It may be as well, with the law that was framed to bring about a better state of things thus shorn of its force, that the secretary of the treasury should have declined to avail himself of the permission the law gives him to invite people to do work for the government for which he is forbidden to pay, and should prefer to go on entrusting the public architecture to the system that has already left it far behind private building.

How far it is behind may be judged from the comparative exhibit of the two that was made at the World's Fair. It was a most impressive object-lesson, the comparison between the buildings reared by private enterprise, under an exceptionally fortunate direction, it is true, and the building erected by the government to represent it to its own citizens and to foreign visitors. If the American people were not capable of learning the lesson there put before them ; if even a representative or a senator could not see the difference—then it is quite idle to hope for any change for the better in our official architecture. While the practice of architecture, as shown in the academic exercises that a singular good fortune enabled to be actually reared in Jackson Park, has been steadily advancing in the country at large, the official architecture of the country has been as steadily deteriorating, until now it has relapsed into positive barbarism. It was not so in colonial times, or in the early days of the republic. Then the public buildings were the best that we could do. The old "Federal Hall" in Wall street impressed a British visitor of just a century ago as the only edifice in New York worth looking at, and within a generation afterwards such public buildings as the City Hall of New York and the State House of Boston showed that the State understood and desired the best that its citizens could do. Nay, take as a standard of comparison the public buildings at Washington, and draw the line at the middle of the century. With all their defects and inequalities, the public buildings erected before that date did really represent the highest architectural attainment that was available at the time. Who that has seen both Washington and the World's Fair, even if he be a member of Congress, can fail to perceive that it would be for the credit of the country if the existing public buildings at the capital were to be replaced by structures erected from the designs of those architects whose work was shown at Chicago? We are not saying that the formal and academic style that is common to the public buildings and the exposition buildings would be desirable for adoption in permanent and representative buildings of our country and our time. But precisely because their classicism is common to both, a just comparison can be instituted, and the comparison is at every point favorable to the later designers. There is juster proportion, more dignity, more breadth, more stateliness, more repose in the general composition of their works, as there is more refinement, more purity, a nicer adjustment and scale in the detail. In a word, they show more architectural quality. On the other hand, let anybody figure to himself a new group of public buildings at the capital by the author of the Government building at the Columbian Exposition! The imagination of the untutored observer must recoil from such a prospect. For stateliness, it shows pretension; for distinction, commonness; for repose, restlessness; for elegance, crudity. It is in this comparison the work of barbarians impudently confronting the monuments of a high civilization. Nay, there is scarcely a comparison that can be made upon the Fair-grounds, except with the very crudest and most illiterate of the State buildings, and not with more than two or three even of them, by which the government of the United States does not appear to disadvantage.

And yet, under the system that has grown up with the acquiescence of our lawmakers, it is not to the architects of the Court of Honor but to the architect of the Government building that we should turn in case it were necessary to add to the public buildings of the capital. The deterioration in our official architecture has been at least as progressive as the advance in our private architecture. The latest of the great public buildings, happily, is the building of the State, War, and Navy departments, one of the works of Mr. Mullett. It argued a deep architectural insensibility to add this fussy and multifarious structure to the collection of simple, quiet, and decorous public buildings at Washington. And yet itself becomes respectable and almost distinguished when it is compared with the government's exhibit of its official architecture at the World's Fair. The protest that the sensitive visitor to Washington feels called upon to enter against the intruder upon its peace, the shade of Mullett would be entitled to repeat against bestowing upon his work the neighborhood of a newer building by the author of the Government building at the World's Fair.

And consider that the quality of the Government building at the World's Fair is the architectural quality of the work that the government is doing all over the country, and spending more money upon, year after year, than was ever spent upon architecture by a single nation. There is much to be said about the official architecture of our lesser political divisions,—of States and municipalities. The rule is that no official person cares about it, or takes thought for it, and the rule consequently is that it is pretty bad. But the rule is mitigated by occasional exceptions. In any case, and if there were no exceptions, the mischief that is done by the workings of officialism in the architecture of States and municipalities would sink into insignificance compared with the mischief that is done in the architecture of the national government. We are spending enormously and profusely every year to pervert the perceptions of the people of the United States respecting the art of architecture. What can the beneficent influence of a group of monumental buildings in transitory plaster of which a fraction of the people have had the vision for a day or two do to counteract the malign influence of permanent buildings, in the sight of which the people pass their lives;—an influence that reaches into every quarter of the land, and into every Congressional district that exults in an enterprising member who insists that his constituency shall have its share of what is going?

ELECTRICITY

Conducted by Franklin L. Pope.

THE fire-losses in the United States for the year 1893 are variously estimated by the insurance experts at from $150,000,000 to $190,000,000, being something like $25,000,000 in excess even of those of 1892, which was regarded as one of the worst years in the history of the business. It is asserted that the entire fire-insurance business of the country for the past twenty years has not paid a dollar of profit to the underwriters, the credit balances of the few successful companies being much more than offset by the losses of the others. An effort is now being made by the New England Insurance Exchange to ascertain the classes of risks which have been notoriously unprofitable, and to increase the rates on such property to a paying basis. Whether rightfully or not, it is certain that the insurance companies are becoming more and more disposed to attribute the enormously-augmented fire-losses of late years to the increased use of electricity. It is peculiarly difficult, however, for various reasons, to get at the truth of the matter. Every well-informed electrician is perfectly well aware that from all low-tension direct-current systems of electrical distribution, especially those which are not insulated from the earth,—as is almost universally the case with electric-railway circuits,—there is constant and imminent danger of fire, unless all the wiring and fitting has been carefully and intelligently done and is kept under constant inspection. On the other hand, with the alternating system, which has become almost universally employed for lighting, experience has shown the fire-risk to be very small. That the increased losses of late years, if attributable to electricity at all, must be due to defective and careless construction, would seem to be proved by the fact that no especial complaint appears to have been made by the underwriters in the large European cities, in many of which the use of electricity has become as general as it is in those of the United States.

THE great number of electric-light and -power stations which have been destroyed by fire during the past few years is doubtless one thing which has had much to do with the present attitude of the underwriters. The fact that so many disasters of this kind have occurred inevitably raises a presumption that there must be something peculiarly hazardous in connection with the machinery and processes for generating electricity. Yet in the majority of instances within the knowledge of the writer such fires have originated from some cause wholly unconnected with the electrical machinery. It is difficult to understand the incredible folly of many of the electrical companies in housing large quantities of expensive machinery in combustible buildings. There will be found buildings with wooden floors saturated with oil; dynamo-belts, often running from one floor to another, likewise saturated with oil; rooms ceiled and sheathed with yellow-pine boards; switchboards of varnished wood, and so on. A central station is nothing more than a large shed; hence it is by no means unreasonably expensive to build it with brick walls, an iron roof and a non-combustible floor, or to make use of slate or marble switchboards and fireproof wiring; yet such construction in this country is the exception and not the rule. As we write a flagrant example of this particular variety of imbecility presents itself, in news of the destruction of a large power-station situated midway between two thriving Massachusetts towns, to both of which it furnished not only light, but also motive-power for twenty-five miles of street-railway. The building was set on fire by the explosion of a hand lantern, and the flames spread so quickly that the employés barely escaped with their lives, with the loss of all their effects. In this case nearly $75,000 worth of valuable machinery was destroyed, while the loss, inconvenience, and danger to the communities who depended upon the establishment for light and transportation is a serious item. Only a few months ago a new station in a New Jersey city of 50,000 inhabitants was burned in almost the same manner, but the warning was of no avail; the station has been rebuilt with new machinery exactly as it was before, and doubtless will be burned again within the next five years. Unless an electric company can afford to put up a fireproof building for its central station it has no business to ask the community to patronize it; the entire municipality may be left without light and power at a moment's notice and the gravest inconveniences and dangers may ensue. If the underwriters should finally conclude to refuse absolutely to insure electric stations it might possibly be an advantage to the public as well as to themselves, if the present aspect of affairs is to continue.

THE Metropolitan Traction Co. of New York has generously offered a prize of $50,000 to any inventor who, before March, 1894, shall bring forward a system of propulsion for street-railway service which shall approximate the trolley as a standard of economy, but shall be without features "objectionable to the public." This is clearly an impossibility. No system of improved transit,—no other improvement whatsoever in any public service,—can be devised by the wit of man which will not be in the highest degree "objectionable" to the enlightened managers of the New York daily newspapers. As the so-called "public" really has no idea whatever in reference to such matters, but merely crude notions and senseless prejudices which are derived from a hasty perusal of the "scare-heads" of the above-mentioned manufacturers of alleged "public opinion," it is evident that the Metropolitan company is in no immediate danger of being compelled to part with its $50,000. We suggest, by way of amendment, that New York city be ruled out of the competition.

THE message of Governor Flower, of New York, and the annual reports of the State engineer and superintendent of public works have made their appearance. Each of these officials has considerable to say in reference to the question of the application of electricity to the propulsion of boats on the Erie canal, but it must be confessed that they have thrown very little new light on the subject. Briefly, the governor seems to be of the opinion that, inasmuch as the present canal is not worked nearly to its maximum capacity, it is not worth while to increase its depth until the present cost of transportation has been materially lessened by the application of electricity. This line of reasoning appears to us to be fallacious. The question of the enlargement of the canal is one thing, and the question of the best motive-power to be used on it is another. Every engineer, as well as every practical canal-man, understands perfectly well one thing which the governor seems to have overlooked: that neither electricity, nor steam, nor mules, can move a boat either rapidly or economically unless there is plenty of water underneath it. The canal is not worked to its capacity simply because it does not pay well enough under existing conditions to induce additional capital to embark in the canal freighting business. If there were only a foot more depth of water horse-boats could make seven trips per season with certainty, where they now seldom make more than six, and even at the present low rates of freight,—which, by the way, are obviously due to the competition of the four-track New York Central railroad, and not to that of the steam-barges,—would then be able to make a fair profit where they now lose money.

THE report of the New York State superintendent of public works contains some further information, which only serves to deepen the mystery which envelops the real object of the exhibition at Pittsford a few weeks ago. The capability of electricity to propel a boat with efficiency, and especially with economy, was sufficiently demonstrated, if indeed any demonstration were needed, by the magnificent record of the electric launches at the World's Fair, recently referred to in this Department. Yet the electrician who watched the canal experiment in behalf of the State officials makes the astounding report that no less than 5.35 electrical horse-power were required merely to revolve the propeller when out of the water, and that the aggregate loss from friction in the machinery and from inefficiency of the electric motors was actually 20 per cent. of the gross power expended! We have heretofore adverted to the absurd inaptitude of the devices employed to convey the current from the trolley-wire to the boat. The total expenditure of power required to attain a speed of 2.65 miles per hour, against a head-wind and the ordinary current of the canal, is given as 24.87 electrical horse-power. Inasmuch as two boats each of the same capacity are towed at an average rate of 1.5 miles per hour by a team of three mules, it is obvious that the Erie-canal electricians will have to do better than this to stand much of a show in the way of competition. The conjecture may perhaps be hazarded that the Pittsford demonstration was intended to be nothing more than the forerunner of some measure which in due time may make its appearance in the legislature, conferring upon a favored corporation the exclusive right to supply electricity to the canal boatmen. It is to be hoped that nothing of the kind will be done. If it be decided to introduce this agency for canal purposes, the State should by all means own the trolley-lines and accompanying structures and regulate their use, while the contract for furnishing electricity upon each section should be awarded, under proper restrictions, to the lowest bidder.

THE observations of State Engineer Schenck in reference to the application of electricity on the canals certainly evince a more intelligent appreciation of the problem as a whole than do those of the other State officials. The problem, as Mr. Schenck clearly perceives, is almost purely an economical one. From the figures procured by him from the Albany electric railway he reaches the conclusion that to obtain one horse-power hour by steam, at a mean distance of eight miles from the power-house, would require from 4½ to 4¾ pounds of coal, which is considerably in excess of the amount now consumed by the canal steamers. He therefore concludes that the transmission and utilization of water-power rather than of steam-power affords the greatest promise of economical success. But in this again he sees a difficulty, in that alternating-current motors must be employed, whereas he states that continuous-current motors alone have thus far proved successful. Mr. Schenck's conclusions are logical enough, but his premises are somewhat at fault. The consumption of power in a street-railway plant furnishes no criterion of what it would be in a system of canal-boats. The waste of power in a street-railway system, due to the irregular and fluctuating loads upon the engines and generators and the varying speeds and frequent stopping and starting of the individual motors, is enormous, amounting at the lowest estimate to one-half the total power generated, while in driving screw-propellers the whole plant, both steam and electric, is worked under conditions of almost ideal efficiency. Then again, the saving in cargo space and in cost of skilled labor on each boat must amount to no inconsiderable figure. The objection that the electric boat must be towed from Albany to New York and back by steam does not appear to us to be an insuperable one; it certainly would cost no more to tow an electric boat down the Hudson by steam than it now does to tow a horse-boat,—namely, $25 loaded or $15 light, or say 10 cents per ton of cargo per trip. The propeller of the electric boat might be unshipped, or suffered to revolve idly in the water, as it need make only a trifling difference in the power required to pull the boat. The total cost, to the canaler, of transporting one ton of cargo from Buffalo to New York is stated by good authority to be in the neighborhood of a dollar, so that it appears he pays the tow-steamer only one tenth of the whole amount for hauling him nearly one-third the distance. It is not to be expected or imagined that any probable application of electricity will be able to reduce the cost of transportation on the Hudson river below its present figure. As for the alternating motor, it probably will be ready when wanted.

A GENTLEMAN whose name has been prominently mentioned in connection with the electricity-on-the-canal experiment above referred to makes the assertion, in the columns of a technical journal, that steam has been in competition with horse- and mule-power upon the Erie canal for many years, and that "statistics" show that up to date the horse and the mule are ahead. Anything may be proved by statistics, but a former report of the State engineer gives the number of steamers as follows, steamers having been introduced in 1872: in 1874 there were 15; in 1878, 19; in 1883, 92. The number now in the service is not officially given, though a greater or less number have been built every year since, which does not look as if steam was altogether a failure. In 1891 a careful estimate of the actual cost of transportation on the Erie canal was made by John Bogart, State engineer. It was found that a four-boat steam fleet could carry grain from Buffalo to New York at a net cost of 2.44 cents per bushel, while the cost by double-header horse-boats was from 2.94 to 3.23 cents, according as the boatman succeeded in making six trips or seven during the season. These figures are given in the engineer's annual report and are made up from carefully-itemized statements. If they are correct it is safe to predict that few horse- or mule-boats will be found on the canal in the year 1900.

THE details of the plans of the mammoth electrical power-plant at Niagara Falls, which have been sedulously concealed from the knowledge of American electricians, have at length been disclosed by one of the consulting engineers, Professor George Forbes, in a paper read by him before the British Institute of Electrical Engineers. The dynamos are horizontal, the revolving parts being carried on the upper end of vertical turbine shafts. Each dynamo is to give a current of nearly 1000 amperes, at a potential of 2000 volts. The type which has been chosen is a two-phase alternator, having a speed of 250 revolutions and a frequency of 25 periods per second. The main distributing conductors are bare and are placed on insulators in subways. Professor Forbes's paper evoked what can be fittingly characterized only as a perfect cyclone of criticism, and many of the details of the plan were emphatically condemned by men eminent in the profession. We venture to express the opinion, however, that in the main the results will ultimately be found to justify the plan which has been adopted. Everything points to the two-phase alternator in quadrature as the type of the universal electric-distribution system of the future, and if this is to be the case the only room for a serious error in principle would seem to be in respect to the frequency which has been decided upon for the alternations. This certainly seems very low, as contrasted with ordinary practice, but it must not be forgotten that the distribution of current for illumination is a very subordinate function of this enormous plant, which is designed primarily almost exclusively for power purposes.

THE advent of the new year is accompanied by a wholesale reduction in the price of electric incandescent lamps, lamps made under the Edison patent being now sold in quantities at about 30 cents each, while rival concerns are advertising others as low as 25 cents. This is a matter of more importance to the consumer than he is likely to realize at the outset. Upon the general assumption that a lamp ought to be expected to burn for a thousand hours,—that is to say, for about a year of ordinary use, —the purchase of a lamp for 25 instead of 50 cents does not appear to be very significant. But when the question comes to be considered in another aspect,—namely, as to the amount of light that can be produced from a given current in a given time from a dollar's worth of lamps,—it will be seen that the saving in the amount of current that must be paid for by meter is by no means an unimportant matter. A moderate reduction in the price of lamps really means a very large reduction in the price of light. If intelligent advantage is taken of the new conditions many a central station which hitherto has barely paid expenses may soon be put upon a dividend-paying basis.

If the valuable information in reference to the installation and management of small electric-light stations which is contained in Mr. Talbot's article in the present number of this Magazine could have been laid before the public several years ago, not only might a large waste of capital have been prevented, perhaps, but a great many enterprises of this kind, now struggling under a discouraging burden of financial and engineering mistakes, might by this time have been in a prosperous and flourishing condition. It has been frequently pointed out in these notes that the majority of electric-lighting enterprises in towns of 5000 inhabitants and under, as a matter of fact, earn but little more than their expenses. Most of them have been unskillfully planned; many of them are unintelligently managed, while, as Mr. Talbot clearly shows, the margin between gain and loss is so narrow as to leave but little margin of allowance for errors, either of plan or of administration. While emphatically approving of Mr. Talbot's suggestion that disinterested and competent expert advice should be secured in all cases, before undertaking a work of this kind, we may venture a word of caution: that not every one who arrogates to himself the title of "electrical engineer" is to be taken at his word, without investigation. Within a very short time a number of enterprising citizens in a certain locality in New England formed a company and commenced the construction of a plant with the intention of furnishing electric light to a town of 3000 or 4000 inhabitants. Under the advice of an alleged electrical expert—whose name, by the way, is not found on the rolls of the Institute of Electrical Engineers—four water-privileges were secured, situated at different points upon the same stream, which were "estimated" (though not demonstrated) to have a capacity each of 75 to 100 horse-power. These were situated at an average distance of nearly eight miles from the town which it was proposed to light. A canvass was made for the purpose of securing consumers, and as the lights were to run by water-power, and of course without expense, the prices promised were but little more than half the standard rates in other towns. No allowance for losses in the machinery and transmission were figured, the general manager asserting with the confidence of inexperience that ten 16-candle-power lights could be furnished for each theoretical horse-power at the fall. But when confronted with the problem of assembling the power of the four water-privileges, without installing a complete generating, transmitting, and distributing plant, with its separate outfit of apparatus and attendants, in connection with each water-privilege, it appeared that it had been assumed, as a matter of course, that there could be no practical difficulty about that, as it was possible to do almost anything with electricity. Pending the solution of this engineering enigma it is understood that the work of construction, which had hitherto been going on briskly, has been temporarily suspended.

The supreme court of Massachusetts has decided, in an action brought by a hackman to recover damages for injuries sustained by the falling of an insulator from an overhead trolley-wire, that the railway company was guilty of negligence in not making its structure strong enough for the strain to which it was necessarily subjected when in use. The mutual rights and duties of the drivers of vehicles and of electric cars have also been defined, by another decision of the same court, in a case in which a horse was frightened by the gong of a car some distance away, notwithstanding which the motorman continued to sound his alarm, resulting in the flight of the horse and a serious accident to the occupants of the vehicle. The court held that the rights of the two parties in the street were equal, and that each was bound to use it with a reasonable regard for the safety and convenience of the other, and hence that it was the duty of the motorman to look out that he was not unnecessarily frightening horses, or putting in peril other persons lawfully using the street, either on foot or with vehicles.

THE American Bell Telephone Co. has paid in dividends, from 1880 to 1893 inclusive, a total of $23,100,000, being an average per year of $1,750,435, on an average capitalization during the same period of $11,209,035. The fundamental patents on the telephone are now public property, the last one having expired on January 30 of the present year. The company still holds many unexpired patents of value covering subsidiary inventions relating, for the most part, to long-distance transmission and to apparatus for facilitating exchange operations.

ALTHOUGH there has been no legislation in Massachusetts compelling electrical companies to place their wires underground, the returns for 1893 show that in respect to the comparative length of telephone wires in subterranean conduits Boston is among the foremost cities of the world. The total length of underground telephone conductors now in operation in that city is no less than 8250 miles. The work in that city was commenced as far back as 1881, but it is worthy of note that all the cables which were in use up to six years ago have been removed and replaced by new ones having a largely-increased capacity for conveying telephonic currents. The new cables are composed of copper wires, insulated with paper or fiber. They are twisted together in pairs, after which the pairs are laid up in reverse spirals to neutralize induction, and the whole covered with an impervious sheath of lead containing an admixture of a small proportion of tin, which alloy has been found to resist decay much better than pure lead. The work of placing the telephone wires underground is now going forward in a number of other Massachusetts cities. A comparison of percentages shows that in London practically the whole telephone-exchange system is overhead, being carried over the housetops, while in Berlin only 52 per cent. of the entire mileage is underground, as against 80 per cent. in the old part of Boston. The proportion of underground wire in New York is nearly as great as in Boston.

THE new power-station which has just been built for the Brooklyn City Railroad Co., at the corner of Kent and Division avenues, is a notable piece of work. The building is on the water-front and covers an area of 255x205 feet. There are 18 pairs of boilers, rated at 500 horse-power per pair, and six horizontal cross-compound engines, having cylinders of 32 and and 62 inches diameter and 60 inches stroke, rated at 2000 horse-power each. Each engine is coupled directly to a 1500 kilowatts twelve-pole generator, and the six combined machines are arranged in two rows of three,—one on each side of the engine-room. The stack is 292 feet high and weighs about 3000 tons. Everything about the station is fireproof, and the greatest precautions have been taken to avoid any possible necessity of shutting down in consequence of an accident to any portion of the machinery or equipment. The capacity of the plant is sufficient to operate something like 2000 cars at once.

ONE of the largest electric plants now operated by water-power is that of the aluminum company at Neuhausen, Switzland. There are eight turbines of the Jonval type, of 600 horse-power each, running at 150 revolutions per minute, and one of 300 horse-power running at 250 revolutions per minute. The water is admitted from below, and thus the pressure serves to balance and carry the weight of the wheels. Each turbine has a 24-pole generator coupled directly to it, the output of which is used in the electric smelting furnace. The capacity of the plant is about 5500 pounds of aluminum per day.

ARCHITECTVRE

Conducted by Barr Ferree.

THE yearly exhibition of the Architectural League of New York is considered by many—and especially by the League itself—the architectural event of the time. Certainly it is the most numerous collection of architectural drawings to be seen at any time in America, and while it is nominally a local exhibition, and was never more so than this year, it is entitled to respectful consideration, though it may not be possible always to develop enthusiasm for it. But the exhibition this year, which recently closed, was a really notable one. It was by far the largest in point of numbers that the League has yet had, the total number of entries in the catalogue reaching 809, with many unnumbered exhibits. A good many of these referred to objects not architectural, but, under the heading of allied and decorative arts, included a miscellaneous collection of objects, from cartoons for frescoes and stained-glass windows to embroideries and pieces of iron-work. It seems a pity that the League should burden its exhibition with objects of this description. Interesting and valuable as many of them are, they help nevertheless to divert public attention from the more serious purpose of the exhibition, which is architecture. This condition was further complicated this year by the joint-exhibition of the Sculpture Society, which tended to reduce architecture to an almost subordinate position in its own exhibition. So long as architecture itself maintains the dominating position no objection can be taken to the inclusion of other phases of art, especially if they actually serve their nominal purpose of attracting the "public." There is no subject on which that great and mighty body needs instruction and light more than it does on architecture, and if the League succeeds in giving this it will have accomplished a greater end, have achieved a more magnificent triumph, and be entitled to a greater reward, than any contemporary artistic body.

BUT there is not the slightest ground for supposing that this result will be achieved from the recent exhibition or from any other conducted on the same basis. On the contrary, one rather looked for an unarchitectural show among so much that did not belong to architecture. And one was not disappointed. In the first place, there was an unusually small number of architectural drawings in the collection. Water-colors there were galore, and most astonishing water-colors many of them were. These were pretty pictures intended to catch the public's eye, without any save a pictorial value, and affording no contribution to architectural knowledge or illustration. Huge office-buildings, immense hotels, vast country-seats—embellished with whole mountains in the background—city dwellings and country houses, details and views of cities were all shown in the medium of water-color. The walls of the gallery blazed with colors quite as brilliant as one would wish to see in a collection of paintings. Even the worst of these,—and there were many such,—represented a great expenditure of money that had better have been spent in preparing drawings of architectural interest and value. There is no sense whatever in making a water-color of a sixteen-story office-building, and while the trustees of a hospital or of a museum might require a water-color drawing to attract interest to their work, there is no reason why every sort of building under all circumstances should be illustrated in this medium. First of all, therefore, the exhibition began with being unarchitectural. It well seconded this extraordinary position by the lack of plans. Though plans were few in number, the average was a good deal higher than at any previous exhibition. We counted thirty plans attached to drawings in the Vanderbilt gallery, in which most of the architectural drawings were placed. It is true that many of these were small and of little value, but, considering the place and the circumstance, no great fault can be found with this number. There might well have been many more, and certainly there was great need of a plan to illustrate the water-color of the new building for the Brooklyn Museum of Arts and Sciences, shown by McKim, Mead & White. For an institution of so high-sounding a title to put out a "picture" of its new building with the idea that people might study it, indicates a most deplorable conception of what is right.

THOSE of our readers who are of an historical turn of mind may recall some paragraphs in this Department, about a year ago, anent architectural competitions and the juries who undertook to decide them. Incidentally, we pointed out a tendency of this work to fall into the hands of the professors in the architectural schools and submitted some reasons why these worthy gentlemen were not always desirable for such work. In itself this was a point of no great consequence, but it helped to enforce what we had intended to be the special lesson to be deduced from our remarks, namely, that the judgment of many architectural competitions by the same authority was detrimental to the progress of architecture. What is the first thing the competing architect thinks of when he composes his mind to thoughts for a competition design? The judge. The criminal in the prison entertains no more wholesome fear or distrust of his judge than the competing architect of the gentleman or gentlemen on whose decision will depend the obtaining of the work desired. The idea of a competent opinion on the drawing as a work of architecture is quite lost sight of in the scramble for the work and the commission it will bring. Everything rests on the judge,—or the jury, if a plural form is preferred. His tastes, his inclination, his judgments in other competitions are carefully reviewed, considered, and digested. The design is forthwith begun with all this well in view. The style is the judge's style, the form is his, the detail,—the plan, if possible. It may be a style that the architect is himself unfamiliar with, it may be unsuited to the type of structure—a most important fact that few people appear to have grasped as yet—it may be bad in itself. But it is the judge's, and that is all that is needed. It seems scarcely necessary to point out how stifling this is to progressive art, how it is binding current work within bands of iron, keeping down original thought, insisting on a common standard for all things, unifying architecture as it never was unified before. And so while the sentimentalists and very young men are telling us that competitions are providing opportunities for slumbering geniuses, opening the way to those who otherwise would knock unheard at the gates of fame, it is nevertheless a fact that competitions are slowly drawing the life-blood out of current architecture; they are stupefying progress and putting a premium on pampering the ideas of an external party.

WE are living in a veritable age of competitions. On every side programs are issuing from the press and the typewriter, or they may not be proposed at all, the architect being left to his own devices. Closed and open competitions are now proposed for almost every type of structure under the sun, and a jury or committee appointed to pass on their respective merits. It is a well-established principle in law, we believe, that no man shall occupy the judicial bench who is not a lawyer and who has not proved his fitness by practice and study. It would seem to be only in accordance with the dictates of common sense to require the same knowledge, the same proof of fitness, in the architectural judge. A competition for a thirty-story office-building is proposed; yet who is capable of rendering a decision? Who has ever built a thirty-story office-building, or even given the smallest hint that he understood how it should be treated and what it should signify? One does not need to have built a building in order to judge its architectural merit, but one surely needs to give some indication that he understands the problem to be worked out. And unless there is a competent judge there can be no successful competition. While this much certainly is clear, yet day after day the same people run the risk of being chosen to judge competitions, with the chief result that the buildings erected correspond to their own individual ideas of what is good. Continue the process long enough and the future historian of American architecture will be able to trace certain distinctive periods in our work which may be called the "Jones period" or the "Smith period,"—not because Jones or Smith devised a style of his own which had a more or less certain vogue, but because they influenced the taste of their time by sitting in judgment in competitions. This is a pretty howdy-do, and something quite new to boot. It remains entirely with the architects whether they will permit such a state of things or not. They have only to form an Anti-Competition League and stay out of competitions, and the whole of the great artificial fabric that is being reared with their help falls to the ground. The continuance of the system rests wholly with them. The dissatisfaction with it that we find prevalent among the professional should take visible form in some such manner as here suggested. Sooner or later the retarding effect of competitions will be recognized, and the sooner the better.

Few questions are so interesting and important to the young architect as the method of advancing himself in his profession. An architect's light somewhat necessarily shines under a bushel; a very important point with him is emergence to a hill-top, where it may be seen of all men. Various ways are tried to the obtaining of this end. The blowing of one's trumpet is one way, and logically rests on the proposition that if one does not blow one's own trumpet no one else will. There is a world of truth in this which every one must appreciate. The difficulty seems to be in determining the manner in which the trumpet shall be blown. The perpetual propulsion of air through this instrument is apt to become wearisome after a time and quite fail of its end; for obnoxious trumpet-blowing is worse than none at all. It seems to be an art that requires the utmost care, and is not to be commended for general practice. Then there is what may be termed the faddic method, in which the interest of a so-called critic is enlisted and public sympathy aroused in this manner. Examples of the successful workings of this system are too well known to be enumerated here. It implies a dishonesty of purpose and a personal interest that destroys the value of architectural criticism and renders those benefited by it objects of suspicion by those who cannot boast a critic among their individual possessions. As for the critic, his (or her) position is very much like that of the court-jesters of ancient history,—the personal property of their lord and master, without any special individual right for existence. Then there is the public method, interviews in the press, published drawings, and the like—a sort of combination of the previously-described methods. The professional journals are likewise made use of to a certain extent, but who looks into the professional journals save the professionals themselves, and others interested in architecture but who are not giving out work? The competitive method has lately come into use, but even this is balked by the provision inserted in every well-drawn program, that a competent architect shall be associated with the winner if he be deemed unsuitable, on account of age or inexperience, to perform the work himself. No one profits by such competitions, and, incidentally, no one but a skilled practitioner is likely to be successful in the average competition. It is a great problem; can any one help in its solution?

It is quite to be expected that the architecture of the World's Columbian Exposition will be echoed and reëchoed for many years to come, and especially in the public buildings of this country. American architects are prone to use the material most closely at their hands without regard to its suitability to the special purpose they may be working upon. The Fair buildings being temporary structures, their forms and ideals may safely be copied without reproducing actual structures. The authors of the Agricultural building have themselves set a notable example in this respect in their design for the Brooklyn Institute Museum, which is a frank development of their Chicago building. Others will doubtless follow suit and we shall probably see much of the Fair for years to come. Apart from the Brooklyn example the most noticeable effect yet manifested was seen in the competition for the Public Library and Museum at Milwaukee. This was a public competition and the opportunity it offered to architects to distinguish themselves was availed of by about seventy. As was to be expected, all sorts of designs, good, bad, and indifferent, were sent in, but the most striking feature of the collection was the reproduction of motifs from the Fair buildings. Not that the buildings were reproduced *in toto*, but the domes of the Agricultural Hall and the Palace of the Fine Arts had several reproductions, the towers of Machinery Hall come in for their share, and sundry other ideas were copied and embodied in the competitive designs. Such reproductions are just what might have been looked for, and this competition is probably only the first of a series in which the same duplication will be noted. It cannot be said that the additions thus made to the vocabulary—if so it may be called—of American architects is a useful one. An architectural form is something not to be copied but to be developed. The mere placing of a dome on top of a building implies no competency on the part of the architect if he has not placed it well, nor does the borrowing of a tower, simply because it is borrowed, express anything. The designs in the Milwaukee competition, apart from this incorporating of new motifs, were not, as a whole, good. They ran from Renaissance to Romanesque, with the perhaps not unexpected result that the Romanesque designs were quieter, more sedate, more stately, and apparently more suitable than the more ornate productions of the Renaissance, even with or without the example of the Fair buildings. The design finally chosen was Renaissance.

FROM time to time we have made it our business to point out some of the manifest and general excellencies of commercial architecture in Chicago. We have not hesitated to point out that some of it was very bad, but on an average it is superior to the commercial architecture of New York because a good deal of it illustrates an honest, manful attempt to make a building, while the prevailing note of New York commercial architecture is to make a façade, to use up the space in the best possible way, and to be satisfied if ideas hold out until the top is reached. In some instances the commercial architecture of Chicago rises to the very highest point of the artistic, so far as a commercial building can be artistic, which may be seen in the Schiller Theater, to speak directly and to the point, Were this an age of progressive architecture an artistic building like the Schiller would be seized upon by every designer of a high building and the progress attained in that used as the basis for further progress and study. Alas! this is not a progressive age in architecture, though never did an age stand in greater need of progress. We do things in this day pretty much as we please, without regard to what other people did and how they did it. In a measure this is sound doctrine, and especially so in relation with the high building, which is something entirely new under the sun. But because the high building is new it does not imply that every designer should seek to solve it upon his own hook, without regard to what others are doing. The sensible way is to find out what progress has been made and use that in further steps of progress.

ALL this is naturally introductory to the dirge we are about to sing over Chicago architecture, for the progress indicated so brilliantly a couple of years ago has since been departed from in a most unfortunate manner. In writing of Chicago architecture it is no longer possible to speak only of its strong good points, but a good-sized chapter must be devoted to its evil aspects, which, in some respects, quite outdo the horrors of New York commercial architecture in its worst phase. And this all comes from the fact that while the number of architects in Chicago who have given any evidence of actually comprehending the high problem can be counted on the fingers of one hand, all the architects of that most bustling town are convinced not only that they do understand it, but that nobody else does. So we have served up to us a monstrosity like the Columbus Memorial Building, to which we invited the attention of our readers last month,—a quite idealless structure that should have been impossible both of thought and of erection. And so, in a very different way, but nevertheless surely and unmistakably indicative of downward progress, is the new Marshall Field & Co. building. This is a large and dignified building, nine stories in height, situated on a corner lot. It is quite devoid of the eccentricities which made the Columbus building so absurd, but it shows that its author has forgotten how to design a high building, for he has previously done most excellent work that exhibited a full understanding of the problem. Yet as a matter of fact everything is good about this building but the idea and the form. The detail is sufficently well done, the windows and parts are well proportioned, the entire work is dignified and stately; yet it has the crowning misfortune of lacking homogeneity. Horizontal lines, not vertical ones, are the leading elements of the design, and when this is the case with a nine-story building one of the prime essentials—unity—of a high building has been ignored. The basement is two stories, capped with a cornice. Then comes a single story with a cornice over it,—neither basement nor superstructure, but somewhat like Mohammed's coffin, suspended midway between the two. The superstructure proper may be supposed to begin above this story and is three stories high. Its leading motif is a triple bay with round arches in the center of each façade. Over this portion comes a cornice, introduced, apparently, for no other reason than to serve as an excuse for starting a series of two-story bays extending wholly around the building and carrying small round arches one window wide. Then comes a cornice and a frieze-story sufficiently satisfactory in itself, then a broad stately cornice most appropriately crowning the structure, and over this a balustrade that closes the building. There is so much that is good in this front that it seems a pity there should be any bad in it. Yet the bad is badness of idea, not of execution, and when the idea is bad an evil result is not far off.

A NUMBER of large and costly catalogues which have come to our table recently deserve more than a passing notice. The activity with which manufacturers place their goods upon the market naturally results in their putting forth more elaborate descriptions and illustrative matter of new goods and most recent devices than will be found in the current periodical publications of the day, whose business is nominally bringing these things before the attention of consumers. And surely it would be difficult for any manufacturer to issue a more splendid illustration of his products than the sumptuous catalogue recently issued by the Standard Manufacturing Co., of Pittsburgh, illustrative of their bath-tubs, water-closets, and fittings. Superbly gotten up as this book is, the catalogue of the Meyer-Sniffen Co., Limited, of New York, is not second to it, either in elaborateness of detail or in gorgeousness of attire. The goods described and illustrated with most abundant illustration are bath-tubs, plumbing apparatus, water-closets, and the like. Very much the same may be said of the catalogues of the J. L. Mott Iron Works, of New York and Chicago. They send us several richly-illustrated catalogues of sanitary apparatus, tubs, stable-fixings, tiles, and the like, all illustrated in the finest manner. Quite as interesting in its way is the catalogue of the Pierce, Butler & Pierce Manufacturing Co., of Syracuse, N. Y., covering the fields of heating and plumbing supplies.

RAILWAYS

Conducted by Thomas L. Greene.

THE prevailing business depression is leading the railways to practise economy in every direction. Employés are laid off and in many cases wages are reduced also. Retrenchment in the amount of new construction, repairs, and renewals is equivalent in many instances to an abandonment of all that kind of work. The result is severely felt in many important lines of trade which have depended largely upon the railway demand for a market. All feel the loss of trade in greater or less degree; but while business is dull everywhere, the stoppage of all repairs and renewals brings the trade of certain lines to a complete standstill.

Very likely the position of the railway manager has not received the consideraation it deserves. That manager is employed by the owners of the property to operate it for their benefit. Usually a heavy mortgage has to be taken into account whose interest day cannot be passed without the required payments from money accumulating, perhaps, for months; or a failure to declare a dividend would bring discredit and perhaps dismissal, particularly if the company has a long record of such yearly returns to the shareholders. With the necessity for the accumulation of this money staring him in the face, the railway manager retrenches where an immediate saving can be effected. Tradeunionism has made it not so easy to reduce wages, and even if the case is desperate earnings will provide for train expenses. So the easiest thing to do is to stop repairs of equipment, the purchase of rails and ties, or of tools or of the smaller things like lanterns; as the supply on hand diminishes no more is bought; or if purchases are made the seller is told that his bill is "vouchered" for payment when the company has funds.

The custom of handling a railway's surplus earnings makes this course apparently easy. While among manufacturers a certain amount in cash is yearly set aside for depreciation, among carriers the rule is to renew old cars and engines or parts of the track and roadbed yearly, as the same requires it. Thus the sum which the factory accumulates, and which perhaps is spent in one large amount for new machinery, is by the railway method expended annually for a proportionate amount of work. In a time of stress it is easy for a while to check the expenditures for these renewals; nor can it be said that the result is in every case at once disastrous. If a railway has set its face against the English method of paying out all surplus earnings to its shareholders, and has in prosperous times spent liberal sums upon its property, then it can cut down the sums to be expended upon the plant for a year with the knowledge that its good condition will prevent serious harm resulting. Yet even in that case this process of "starving" the property is poor economy. Under the best of circumstances for every dollar thus saved there must be spent two or three dollars when the neglect comes to be made up. Railway-men know this well, but the necessity for the immediate dollar leads them to hope to earn the additional dollars when times become better.

THE case so far presented assumes that equipment and track are in the best condition. The majority of roads are not so fortunately situated. The business depression has caught many lines unprepared for a strain of severe economies very long continued; in those instances lack of repairs may imperil the safety of trains and consequently of passengers and employés; such lack certainly means high cost of operating. In such cases, too, the bondholders or stockholders for the sake of one or two interest or dividend payments are really staking their whole principal. At the end such uneconomical savings will necessitate the spending of large sums upon the property to fit it for its business of transportation, and to effect this a reorganization may then be necessary, involving heavy losses upon all concerned. It would be far better financially, as well as more honorable, if our railway policy allowed a different course. Certain reductions in the sums allotted to renewals are proper in times of depression, but when that depression is long continued, or when a company is not well prepared to stand the strain of such heroic remedies, the best course is for the manager of that company to face the situation. He should explain publicly that certain repairs and other expenditures are a necessity if the road is to be kept running; that the earnings do not at the time warrant such expenditures if returns to capital be continued, but that it would be for the real advantage of the bondholder or stockholder to forego one or two interest or dividend payments to the end that his investment may be finally secured to him. No manager would like to be alone in making such an announcement, and it unquestionably would require moral courage of a high order, yet the public opinion of all concerned,—travelers, shippers, and investors,—ought to sustain such a course as wise and honorable. A plant already in poor condition ought not to bear a further strain because the board of directors think themselves obliged to gamble on future prosperity, with the known odds greatly against them.

But receipts in normal years ought to be large enough to cover such expenses as are specified above. Close observers of the times think they see much danger ahead for railway capital unless conditions change. It is a fact much to be regretted that transportation does not "pay"; that is, the revenues received by the rail carriers are insufficient to meet the proper expenses of renewals and of the better and safer train service now demanded and to leave over a surplus sufficient for a reasonable return on the capital invested. Increases in wages account for this unfortunate fact in part, but the real explanation lies in the gradual but steady decline in the rates received. A decrease in tonnage is indeed usually accompanied by a reduction in tariffs; but beyond all that it is clear that the general average of railway charges is too low. An idea prevailed among the public before the passage of the interstate commerce law that railways were fair game; that reductions in rates were good for the farmers and hurt nobody. We know better now; but meanwhile it was in something of this spirit that the act to regulate commerce was passed. It was not an equitable law, but was enacted in hostility to the carriers. The commissioners so interpreted it, for in one of their early decisions it was held in substance that no power was granted that body to put up rates, no matter how they had been forced down. The question of "unreasonableness" in the act referred to high, not to low, tariffs. The railways play so large a part in our commercial world that when they are cutting wages, discharging men, and postponing inevitable repairs, every one feels it. The annual report of the interstate commerce commission bears directly upon this part of our railway problem.

It is much to their credit that the commissioners ask for authority to prescribe minimum as well as maximum rates. It signifies that rates may be forced by competition too low for the public good. But why should rates be too low? Partly of course through the fault of the railways themselves, but largely through the effect of this same law which the commission asks to have amended. Why not strike out the faulty clauses of the law rather than try to help things by amending them? As we have just said, the general spirit of the law is hostile to the carriers, but two sections of the act are especially so. These are the sections prohibiting pooling and the one forbidding a larger charge for a shorter haul in all cases.

To a certain extent the evil effects of

these two sections run together, though they may be discussed separately. The intent of the act to regulate commerce is to prevent, not discrimination, but unjust discrimination. Discrimination—the art of seeing essential differences between things—is as much a necessity in transportation as in trade. The law was not intended to stop the carriers from charging higher rates upon silks than upon wheat, for instance, though that is discrimination. Whether discrimination is just or unjust depends upon the circumstances of each case, whether the difference in charge corresponds to a well-founded difference in the trade or in the nature of commercial things. Hence it follows that no hard and fast rule can be laid down about this matter of difference of charge without working injury to the railways and, through them, to the community. Now the fundamental objection to the short-haul prohibition is that it decides beforehand and in all cases that a discrimination between places is unjust. There are instances when a higher charge to a local town is clearly inequitable, and there are also instances when it is not unfair; but all are alike condemned under the law as it stands without a hearing, the commission having refused to accept the unbusinesslike proposal of the act and give permission for its violation before the actual putting in force of the disputed rates. In considering complaints of short-haul infractions brought before it, the commission has naturally and logically been guided by the hostile spirit of the law in leaning toward the shippers who were charged what they considered too high rates. But in the few cases in which these decisions of the commission have been passed upon by the courts, we find the judges almost universally holding the commission's opinion to have been inequitable. The case of the city of San Bernardino, California, is an example. Rates from the east to this point were higher than to places on the Pacific coast; the commission ordered them reduced, but the judge denied the asked-for legal relief, holding the commission's action not warranted.

An inland case of the same general tenor is that of Social Circle, a local station on the Georgia railroad between Atlanta and Augusta. Carriages from Cincinnati were charged more to the little town than to Augusta. There was a through rate from Cincinnati to Augusta low enough to meet seaboard competition, while the railroad demanded its local rates from Atlanta to Social Circle, refusing through tariffs from Cincinnati. The commission held that the aggregate of charges from Cincinnati to Social Circle, no matter how made up, must be less than the through charges to Augusta; but the United States court decided against that contention. Another late decision, by putting a fine definition upon the meaning of the word "line," has partly nullified the severity of the law. Without impugning the motives of the well-known jurist who made this decision, we may believe that he was led to that opinion by the clearly inequitable working of that section against the carrier.

The plain fact of the matter is that where a higher charge is made for a shorter distance the case should be examined on its merits. If the whole section were struck from the law, the question of rightfulness could still be brought up before the commission under the other sections forbidding unjust discrimination, with the very important difference that then the dispute would not, as now, be prejudged against the carrier. There is force in the contention of General E. P. Alexander and others that a railway is justified in relying primarily upon its local traffic. If it gets through shipments at a lower proportionate rate, those traffics generally pay something into the treasury and so enable the company to reduce its local charges. It is the duty,—and, we may add, the best policy,—of the railway gradually to quote lower and lower local rates as the general prosperity of the company increases from all its business, until the towns along its line are placed upon an equality with the great cities in selling their produce in the large markets or in bidding for factories. The dispute between the company and its local shippers generally concerns the rapidity with which these reductions may properly be demanded; and this question is a fair one to be referred to an arbitrating body of some kind. For a railway, if very prosperous, is inclined to pay higher dividends rather than reduce rates; hence the fair rule would be to share the larger profits between the stockholders and the local shippers.

THE far-reaching effects of the universal arrangements of tariffs on the basis of a lower charge for a shorter distance are not easily traced in detail, but railway-men believe that to federal and State legislation is due no small share of the responsibility for the insolvency of so many of our leading companies. Judge Dillon records it as his opinion that the troubles of the Union Pacific are due partly to this very cause. The heavy capitalization of that system makes it imperative that earnings should reach a large sum. But its receipts from transcontinental (*i. e.*, Pacific coast) traffic are limited by ocean competition, which lately has been very severe. Its competitors at other and inland points are active. The Union Pacific must thus accept what it can get on much of its tonnage, but cannot fill its declining treasury from its other traffic. Thus we have the curious spectacle of a nation which is a large creditor of a large corporation seeking to imperil its own security by limiting the charges, and therefore the profits of the debtor, upon which it must depend for ultimate payment.

THE local demand for rates as low as the through charges arises partly from the decline in the average through rates, with which the local rates are always being compared. This decline in through charges has been hastened by the interstate act, which forbids pooling. Before 1887 it was customary for the railways to agree upon rates and upon the proportion of the competitive tonnage which each company should carry. In one or two cases,—the roads between Chicago and the Missouri-river cities are examples,—these pools held rates so high as to induce the building of competing railways beyond the needs of the country, and thus brought about their own punishment. But in the majority of cases these railway pools held together only so long as the rates and proportions were commercially equitable; for these pools were mere agreements, non-enforceable in the courts and dependent upon their inherent fairness for their support. Their great merit was that they brought up for discussion in the light of day and put in a way of settlement those disputes which are always arising between rivals having large interests, and which now result in the "cutting" of rates. A "cut" rate is usually an offer of transportation at a price lower than is warranted by the commercial conditions. It is a rate not decided upon on scientific principles or on any ground of reason whatever, but because some rival is supposed by some trick to be getting a better share of the general traffic,—a very poor basis for a change involving, if carried far enough, profits or losses to those engaged in trade and serious results to employés, supply-merchants, and shareholders alike. In what other line of business do we use such rule-of-thumb methods in dealing with grave issues? It is further to be remarked that the prohibition of (unenforceable) pooling or of reasonable agreements among carriers takes from the railways a trade privilege which business men in other lines are not forbidden to use. We do not, for example, prohibit paint-manufacturers from organizing. We know that such agreements cannot be enforced. We know, too, that the prices of paint cannot be sustained at exorbitant figures by verbal or illegal contracts or understandings; therefore we rest content. The action of commercial laws is slower among railways than among paint-dealers, by reason of the largeness of the business of transportation; but the end is as sure in one case as in the other. Among railways, as among merchants, the effect of a trade union in actual practice is to prevent losses,—not to get unjust profits, which indeed are not long possible in either case.

THE one argument relied upon in favor of the prohibition of pooling is that the railways, if left to themselves, would instantly put up rates to an exorbitant figure over the whole country. For the sake of a brief discussion on this point we will assume that the companies have banded themselves together to act as a unit on the rate question, with power to enforce their decisions. We know that the assumed condition is impossible, but we will take the extreme supposition. It is not realized by everybody how little real power over rates rests with the traffic-managers; their actual duties are not to originate tariffs, but to register in their tariffs the existing commercial conditions. The Pacific roads, we may be sure, did not of their own free will put in force a rate of $1 per 100 pounds for the carriage of California products from that State, 3300 miles to the Atlantic seaboard. The market price of a manufactured article at Chicago is fixed by the competitive sales of that article made, let us say, in Alabama, Pennsylvania, Massachusetts, and in Chicago itself. This selling-price, after deducting the cost at the factory, leaves a margin of profit which must be shared between the manufacturer and the carrier. If the railway should charge the whole of this profit for transportation the traffic would cease. In such a case the railway would get nothing. "Enlightened selfishness" must always prevent the railways from establishing such rates as would leave nothing for the shipper; such a policy would ruin their own business. The whole commercial market of the United States is established on a low average charge for transportation. The companies could not greatly alter those charges without involving themselves in bankruptcy. Extortionate tariffs on our railways are, therefore, commercially impossible. Such tariffs are impossible also because of our great waterways, lakes, rivers, and canals, which limit rail charges directly and indirectly to a degree not suspected by the ordinary man. We may therefore consider that the railways are not to be feared even when under a pool, and that even if firmly bound together (conceding this to be possible) they could not practise extortion without ruining themselves and their owners. As things are now, the railways need protection against unjustly low rates much more than their patrons against unjustly high ones. And if so great an interest as that of transportation is not allowed reasonable prosperity, every member of the business body will suffer too.

In this connection should be briefly noticed the contention of the commission that the short-haul section "is nothing but an extension to places of the rule forbidding unjust discrimination between persons." The absurdity of this contention is seen clearly in the light of what has been already said. Discrimination between an occasional traveler and a commuter is regarded as equitable, while no discrimination, fair or unfair, is allowable under that famous section. Again, the commission says that no "railway insolvency can justly be attributed to the operation of the law," and then adds, "the law can operate to limit railway revenue only by preventing unjust charges and undue partiality," which merely begs the question at issue. If a railway goes into receivers' hands it is evidence that its charges were unjust! If every reduction is *ipso facto* a prevention of some injustice, why ask for the right to prescribe minimum rates against excessive competition? Such quibbling should have no place in a public report.

The denunciation of the system of overcharges is emphatic and true. It is a scandal to our railways that, when a palpable error in the computation of charges has been made, a consignee cannot get his property without paying the whole amount asked for, trusting to receive back the overcharge upon presentation of a claim. The companies have had their attention called to the evil many times, but as yet have taken no real steps toward a remedy. Of course it often happens that the delivering road did not make the mistake, but that an intermediary company collected the excess amount and yet holds it. But if those companies could unite in the establishment of through shipments at agreed rates and proportions, they can also consent to the correction of these irritating overcharges at destination at the expense of the member of the line which has retained the money not belonging to it. It is a source of wonder that the mercantile community has borne this gross abuse so long and so patiently. It is time that overcharges, when clearly shown to be errors, should be corrected on demand.

THE announcement of the opening of the great Manchester canal in England and the recent trial of electricity as a motive power on the Erie canal call attention to the question of competition between railways and water-routes. It is an ever present question in the United States because of the natural water-courses. The great lakes and the rivers are always factors in our general rate problems. Mr. Albert Fink's argument showing how the Erie canal affected all inland charges will be remembered. It is sometimes said that the competition has grown dull because the Mississippi river—for example—carries comparatively little commerce. This assumption is erroneous. If grain from Nebraska could reach Europe via that river at a cheaper charge than via the Atlantic seaboard, the grain would be carried through the Mississippi. Nor need any large quantity be so moved in order to affect the rate problem : a little increase would demonstrate the fact of such cheapness, and the mere potentiality would be enough to compel a readjustment of trunk-line tariffs.

Experience demonstrates that a waterway is in the long run no injury to a railway. At first of course it may take some traffic away from the rail carrier, but the cheapness of transportation for the raw materials builds up the city so favored, the railway participating in the prosperity and carrying such a quantity of higher-priced traffic as to more than make up the original loss. The Erie canal has always limited the charges of the New York Central, yet that same road is the envy of its neighbors because of the populous and prospering towns which fill the Hudson and Mohawk valleys. It may be set down as a transportation axiom that anything which benefits a section of the country benefits the carriers also. It is believed by some that the opening of the Nicaragua canal would injure the so-called transcontinental roads. Perhaps so, but if so for a short time only. Any increase in the business of the Pacific coast would be certain in the end to increase the railway traffic as well.

ONE of the troubles of the railways is indicated by some figures on the profits of wheat-growers compiled from the reports of the statistician of the Department of Agriculture. In 1891 we had the unusual combination of a large crop and good prices. In that year the average yield per acre in Minnesota and North Dakota and the average price at the farm gave the wheat farmers of those States upwards of $15 per acre. Careful computations by details put the cost of wheat-growing at $6 per acre, including $1 for use of the land. The great profits of 1891 are therefore apparent. The farmers were very prosperous : they paid off mortgages, rebuilt their houses, and bought pianos, so that all the merchants in their territory had a good trade. The receipts per acre in 1892 were but little more than half those of 1891. But the prosperity of the previous year extended through 1891 also. In 1893, on the contrary, the conditions were reversed : we had a low average yield and a price at the farms as low as 43 cents per bushel ; a combination which gave to the wheat-producers less than $5 per acre on the average,—not enough to pay expenses. The last of the great profits of 1891 were consumed in making both ends meet in 1893. The comparatively small yield and the low prices have left the farmers of the northwest without purchasing power. Until there are better crops or better prices the railways must look for a small tonnage, both for grain out and supplies in. The same thing is true of the winter-wheat States. The wheat-producers cannot for a while support the railways with large shipments either eastward or westward, except for immediate necessities. But as merchants report stocks of goods as small in interior towns, the revival, when it comes, will be accompanied, it is believed, by increased freights.

CIVIL ENGINEERING.

Conducted by John C. Trautwine, Jr.

THE fall, on December 15, of the single-track railway bridge which was being thrown across the Ohio river between Louisville, Kentucky, and the opposite town of Jeffersonville, Indiana, was one of the most serious catastrophes of recent years. The bridge was being constructed by the Phœnix Bridge Co.,—J. Sterling Deans, chief engineer. Of its three channel spans, each of about 550 feet, one was practically complete, the false work having been removed, the second was in place with the exception of one or two panels at the south end, with the false work still under it, while the false work for the third span was just being put in place. The spans weigh about 2,000,000 pounds each. It had been noticed that the traveler swayed somewhat under high winds, and steps were being taken to strengthen it, but while this was being done the false work under it gave way and the structure was hurled into the river, carrying some fifty men with it. A few minutes later the portion of false work in place in the next span fell as a consequence of the destruction of that in the first span. In the evening, the nearly finished span, from which the false work had been removed, fell into the river, entailing, of course, enormous loss, but fortunately without further loss of life. After the fall of the first span it was found that seventeen men were standing on the pier at its end. These men, with the greatest coolness and presence of mind, at once took measures to save the portion of false work in the next span, but their efforts proved unavailing.

The cause of the accident seems to be, as the newspapers would say, shrouded in mystery. Mr. Deans, the engineer for the contractors, claims that the bridge was thrown down by wind of cyclonic force. The records of the weather bureau in Louisville, however, show thirty-six miles per hour as the maximum wind velocity on the day of the accident, a velocity far too slight to account for such an accident if all was as it should be. It might not unreasonably be supposed that the valley of the river formed the path of a wind of much greater velocity than that recorded at the office of the weather bureau, but opposed to this view is the fact that the woods on Towhead island, close to the site of the bridge, afterwards showed no signs of extraordinary wind action. It might, of course, very well be that the wind came in puffs at intervals corresponding to the period of vibration of the traveler or of the truss. Certainly, such very tall single-track bridges,—some 92 feet high by 30 feet wide,—offer a serious temptation to an ill-disposed gust, even after everything is in place. The history of the building of this bridge has been a sad one. Some three or four years ago there were two serious accidents with the foundation caissons, in one of which several men were drowned.

IN designing the superstructure of the great cantilever bridge with which it is proposed to cross the Channel between England and France, where the spans between piers will be 400 and 500 meters (1313 and 1640 feet) respectively, with 65 meters or 213 feet for the maximum depth of trusses, Messrs. Schneider et Cie., of Creusot, have proposed for the deeper portions an arrangement of the trusses so as to give to the bridge a triangular cross-section. In other words, the two trusses will be inclined inward until their top chords meet. The base of the triangle thus formed will be 25 meters, or 81 feet. Within this triangular tube the rails (double track) will be carried by a most formidable structure of trapezoidal form, the base and sides of which will be formed of lattice columns, the lower apices of the trapezoid being framed to the lower chords of the trusses.

The triangular disposition of the trusses offers an extremely simple and rational method of bracing against lateral wind pressure. It is of course applicable only where the depth of the trusses is such as to give sufficient head-room. Towards the ends of the parabolic cantilevers, where the head-room becomes insufficient for a triangular arrangement, the cross section assumes the usual rectangular form. The independent bridges of 125 meters, or 410 feet, span, supported between the ends of the cantilevers, are of rectangular cross section throughout.

In the designs for this greatest of all bridges, as exhibited at Paris in 1889, it was estimated that a million tons of material would be used, that ten years would be occupied in the construction, and that the cost would reach $172,000,000, more than half of which would be required by the superstructure. The line was to cross from Folkestone, on the English side, to a point about a mile south of Cape Griz Nez, on the French side, and about two miles northwest of the town of Ambleteuse, the port of which was to be considerably developed in connection with the bridge operations.

The line of the bridge, which joined the Southeastern railway of England with the Northern railway of France, deflected from a straight line in order to utilize the shoals of Le Verne and Le Colbart, which lie some two or three miles to the south of a line joining the two extremities of the bridge. At each of these points a short curve was introduced, and the line was thus divided into three tangents. The line as now proposed by the Channel Bridge and Railway Co. is straight and nearly twenty-one miles long. It is composed of seventy-three spans with a minimum clearance above high water of 177 feet. The piers, which, with their foundations, are designed by M. H. Hersent, the noted French engineer, are of braced steel columns resting upon masonry supports founded in caissons within coffer-dams. The coffer-dams, in depths greater than about 100 feet, rest upon a foundation of concrete slabs. The mean depth is 120 feet, and the maximum 167 feet. The estimate of the time required for construction has now been reduced from ten to seven years, and the estimated cost from 172 to 134 million dollars, the reduction being chiefly in the item of substructure. The designs were the joint work of Messrs. Schneider and Hersent in France, and of Sir John Fowler and Sir Benjamin Baker in England.

THE design of the foundations and substructure of the Channel bridge is but one of a formidable array of important engineering works in which M. Hersent, either alone or in coöperation with others, has been engaged in the course of his active career of nearly forty years. Among these works the execution of foundations for bridge-piers and quay-walls by means of compressed air forms an important part. Among these we find the bridges of Argenteuil, Orival, and Elbeuf, over the Seine; the Stadtlau and Franz Josef bridges, at Vienna, and the bridge at Linz, over the Danube; the Rhine bridge at Kehl (1859–60), and many others of importance. The improvement of rivers, the construction and improvement of harbors, with the necessary removal of rocky and other obstructions, and the building of docks, locks, and quay-walls, have also engaged a large share of M. Hersent's attention. Prominent among works of this character on which he has been engaged are the regulation of the Danube at Vienna (1870–75), the harbor of Toulon, involving the construction of dry-docks by means of immense metallic caissons, the new harbor works of Antwerp, including 3500 meters of quay-walls on pneumatic foundations, rock-removal and dredging at Cherbourg, the construction of a dry-dock at Saigon, Cochin China, and the reconstruction of the harbor of Lisbon, with 10 kilometers of quays, a system of hydraulic cranes, dry and wet docks, etc.

At present, M. Hersent's firm is engaged in two notable harbor projects: that at Bizerte, in Tunis, and that of Bordeaux. Bizerte—the ancient Hippo-Zarite—lies due south of Sardinia and west of Sicily, just west of the point where the southern or African shore of the Mediterranean makes a right-angle and falls off to the south. It is connected by railway with Bône (where Messrs. Hersent et Cie. have constructed quay-walls) and with other points along the north coast of Africa, and, judging from a beautifully illustrated "Bulletin" issued by the Compagnie du Port de Bizerte, it is evident that its attractions for tourists are to be utilized in its development. The town lies directly on the seashore and on the side of a short and narrow inlet leading to two lakes which lie just back of the town. The nearer portion of the first of these lakes is to be separated from the rest by means of a dam and will form a well-protected harbor. The works will consist principally in the regulation and rectification of the inlet and the construction of quay-walls to protect its entrance. The work at Bordeaux consists in the construction of 1600 meters of quay-walls resting upon masonry piers sunk by the pneumatic process, and embraces 63,000 cubic meters of masonry, 140,000 cubic meters of rock-removal, and 400,000 cubic meters of dredging.

Mr. Georges Hersent, son of this distinguished engineer, has, since his visit to the World's Columbian Exposition, made a tour of the United States and of the isthmus of Panama, visiting California, the mouth of the Mississippi, etc., in order to make a study of the conditions existing here.

PROFESSOR BARKHAUSEN has contributed to the *Zeitschrift des Vereins Deutscher Ingenieure* an account of his visit to the United States and to the World's Fair. He gave special attention, during his stay here, to matters connected with iron and steel construction, and his report includes interesting illustrated descriptions of our methods of bridge- and roof-construction, including hand and machine riveting, eye-bars and pins, etc.

THE engineers of America, and especially the "eighty-niners," or those who visited Europe in 1889 for the purpose of seeing the Paris Exposition, and who shared in the magnificent courtesies extended to American engineers by their European brethren in that year, had made preparations in the hope of being able to visit their appreciation of those hospitalities upon the hosts of European engineers who, it was believed, would visit the World's Fair more or less completely *en masse*, as the American engineers visited Paris. Much to the disappointment of the would-be hosts, however, only one distinct body of engineers visited the United States in that connection. This was the delegation of the Société des Ingénieurs Civils de France, which arrived at New York early in September and sailed away about a month later, having spent about ten days at the Exposition and having visited Niagara, Detroit, St. Louis, Pittsburgh, the Pennsylvania oil-regions, Washington, and Philadelphia, while a few, who remained longer, visited Boston and made a short trip into Canada.

M. Jousselin, the president of the society,—of whose death we have since learned from a correspondent in Paris,—was detained at home by illness in his family, and the delegation was headed by Mr. Louis Rey. This gentleman has contributed to the Mémoires of the society a full and interesting account of the visit. Unfortunately their steamer reached New York harbor just after sundown, and thus, to the forcible impressions which one gets of our protective-tariff system during a detention of an hour or so on the inhospitable wharf at Hoboken, these visitors were enabled to add those gained by an enforced night's stay on shipboard while the customs officers slumbered comfortably at home. The next morning, however, the outstretched arms of the Bedloe's island statue, erected by their own countryman, must have gone far to assure them that they had, after all, reached a free country. A ride upon a New York Central locomotive, on the way to Albany, impressed the visitors with the smoothness of its running, which they attributed largely to the height of its center of gravity above the rails. The fact that one of their number occupied at the Auditorium, in Chicago, a room with a number exceeding 1900, gave these visitors a realizing sense of the dimensions of that caravansary.

The report refers to "a very original discourse" addressed to the party by the late Mayor Harrison, at Chicago. The speaker, we have heard, remarked that as America is the greatest country in the world, as Chicago is the greatest town in America, and as he was mayor of Chicago, it followed that he was the greatest man in the world. It is difficult to believe that even a Chicago mayor could have meant this seriously, but our French friends took it so, and we are thereby reminded of Dr. Holmes's wise remark that it is not what we say, but to whom we say it, that counts.

M. JOUSSELIN was born in 1830 and was for many years in the service of the Paris, Lyons, and Mediterranean railway, where he distinguished himself in the field of signalling, introducing an electrical apparatus of his invention. He was a man of most estimable character, and was most highly esteemed, not only for his technical attainments but perhaps equally for his readiness to aid those who were working upward on lower rounds of the ladder. Our correspondent writes that M. Jousselin "left behind him nothing but regrets." We trust this need not be taken quite literally, as is, however, too often the case with distinguished engineers, especially with those who allow themselves to have a thought for the success of others.

IN Germany, too, the great archer, Death, has been proving his proverbial fondness for a shining mark. The death of Franz Grashof, on October 26, was followed, on November 25, by that of Johann Bauschinger, and thus, within a month, the profession lost two of those bright and shining lights who have done so much to establish the fame of the German engineers as among the foremost investigators and thinkers in practical science.

Grashof, born in July, 1826, was scarcely second to Bauschinger in their common pursuit. He succeeded Redtenbacher at the school of machine-construction of the Carlsruhe Polytechnikum in 1863, and remained one of the faculty of that institution until his death. He was five times elected its director. An apoplectic stroke in 1882 greatly curtailed his activity, yet we find him serving, in addition to his other duties, as a member of a normal commission of measurements since 1882 and as a curator of the Royal Physical and Technical Institution since 1887. To American engineers he is perhaps best known through his great works, "Theorie der Machinenlehre," "Theorie der Elasticität und Festigkeit," and "Resultate der mechanischen Wärmetheorie." He was a director of the Verein Deutscher Ingenieure (Society of German Engineers) from its foundation in 1856 until 1890. The organ of the society, in commenting upon his life and death, says: "For many years Grashof was in fact the embodiment of the society, so intimately had he become associated with it, so incontestable was his influence upon its life."

Bauschinger, who, at the time of his death, was a man of sixty years, was the leader of German investigators of the strength of materials. He was at the head of the mechanical and technical laboratory of the Royal Bavarian Polytechnikum, whose "Mitteilungen" (communications) form part of the classics of that branch of engineering science. This laboratory is to the Germans what Watertown is to the United States, and no great line of study upon strength of materials was there undertaken but Bauschinger must be in the van. He was profoundly interested in the work of the conferences for the unification of methods of testing materials of construction, and to him belonged the credit of their success. Twenty-one of the Mitteilungen have appeared, and at the time of his death the distinguished author was laboring upon the preparation of the twenty-second, which was to contain a further discussion of the behavior of wrought iron under repeated stresses, with a refutation of Autenheimer's hypothesis. Bauschinger was also a professor of graphic statistics, and his work on that subject, published in 1871, is well known to the engineering profession.

PROFESSOR TYNDALL was perhaps less closely related to the engineering profession than were these two great German students, but he spoke our language, and his death may be to us perhaps even a greater loss than theirs. Certainly those favored few who enjoyed that rarest of all the rare treats provided for the "eighty-niners," the lunch with Tyndall in his home at Haslemere, and who can recall the tearful eloquence with which that grand old man spoke of the brotherhood of engineers and scientists on both sides of the Atlantic, can regard his death as nothing less than a personal bereavement.

THE last few months have seen a radical change in the appearance of the Delaware river in front of Philadelphia. Until within the time named, the channel has been obstructed by the presence of two islands—Smith's and Windmill by name—with a combined area of about twenty-five acres. The two islands, originally one, formed an obstruction about a half mile long in the axis of the river, and greatly interfered with traffic between Philadelphia and its opposite neighbor, Camden, on the New Jersey side of the river. For this reason a canal was many years ago cut through, dividing the island into two portions and offering a passage-way for the steam ferry-boats plying between the two cities. The northern portion, called Smith's island, has from time immemorial been a place of popular resort, formerly for the mixed population of men and boys who infested the districts lying near the wharves of both cities, and, more lately, under the name of Ridgway Park, for a perhaps somewhat more select clientage. Upon the southern portion, or Windmill island, stood several manufacturing establishments, while its extreme lower end was for some years occupied by the Sanitarium, a charitable resort for sick children. The islands have now been dredged away to a depth of about twelve feet below low-water mark, and their removal will admit of and be followed by a considerable extension in the length of the wharves on both sides of the river, the object of which is not only to give increased wharfage, but also to reduce the channel to approximately the same effective width as it had before the removal of the islands.

The discovery, within a few weeks, of the remains of an old schooner at about low-water level, seems to indicate that the islands in their present shape may owe their existence to the presence of this obstruction. About a mile and a half further up stream, and opposite to Cramp's shipyard and the great coal-wharves of the Philadelphia and Reading railroad, or at about the extreme northern end of the port of Philadelphia, lies Petty's or Treaty island. This island, about two miles long and much wider than Smith's or Windmill island, is nevertheless, owing to its location, a less important obstruction to navigation. About 1000 feet of its western side are however being dredged away, so as to give a uniform width of channel of 1900 feet between the island and the Philadelphia shore. At the same time operations are in progress for cutting off the eastern channel between the island and the New Jersey shore, in order to confine the current to the western or Philadelphia channel. A pile and stone jetty, for this purpose, is now nearly completed.

A pile jetty is also being constructed at the mouth of the Schuylkill river where that stream enters the Delaware river, at the southern end of the city. The object of this work is to prevent the submergence of certain mud flats at that point, and thus to confine the entire current within the channel proper. This jetty is so located as to exclude as much as possible of the flood tide. Major Raymond, by locating the jetty in this way, flies in the face of the established theory governing such matters. His argument, however, is that in this case the flood tide brings all the sediment, while the ebb and the freshets, owing to the presence of Fairmount dam a few miles up the river, are comparatively free from sediment. Major Raymond's theory is strengthened by the fact that in numerous cases where jetties were perforce located in this way, excluding a large portion of the flood tide, a deepening of the channel resulted.

Mr. Hoech points out that our rendering of his remarks in describing the North Sea and Baltic ship-canal, as given in our January issue, is liable to misconstruction, inasmuch as it conveys the impression that the emperor had, by mere fiat, arbitrarily modified the designs of the engineer. What Mr. Hoech wished to express was that the emperor had expressed the desire that a second railway-crossing might be accomplished by means of a high-level iron arched bridge, like the one already executed at Gruenenthal, whereas the engineers, from motives of economy, had proposed a draw-bridge for the second crossing. It eventually transpired, however, that the construction of the canal had been carried out so economically and the cost kept so far within the appropriation, that it became practicable to carry out the emperor's acceptable suggestion.

The Midland and Great Northern railways, of England, which have bought up the Eastern and Midlands, are reconstructting the bridges of the latter so as to bring them up to the standards of the new owners. Mr. T. Graham Gribble, the former conductor of this department of the Magazine, who is engaged in this work, informs us that the load-assumptions are much heavier than those employed in America, and that the dead weight is included, to allow for corrosion.

Mr. James F. Smith, a veteran civil engineer, celebrated Christmas Day and his eightieth birthday at the same time, in Reading, Pennsylvania. Mr. Smith is ex-president of the East Pennsylvania railroad, and was for many years president of the Schuylkill Navigation Co. The festivities were attended by a large number of sons and grandsons, most of whom are engaged either in active engineering or in the service of transportation companies. Among these was Mr. Edwin F. Smith, son of the veteran, who is superintendent of the Philadelphia and Reading Terminal in Philadelphia.

On November 1 the Italian railways, by royal decree, adopted the time of central Europe, which is one hour faster than Greenwich time, and 50 minutes 39 seconds faster than French railway-time, or that of the meridian of Paris. The twenty-four hour system was also adopted at the same time, the hours numbering from midnight to midnight, so that members of the American Society of Civil Engineers may reflect, as they read their notices of meetings to be held at 20 o'clock, that they are not alone in the world.

In this Department last month a brief reference was made to the appearance of Mr. Suplee's translation of Reuleaux's great work, "Der Konstrukteur." Since that time, the translator has presented to the American Society of Mechanical Engineers a handsome full size portrait of the author. The portrait, which is the work of Mr. Suplee's sister, will now grace the same room with that of the great English scientist and engineer, Professor Rankine.

The contest over the secretaryship of the American Society of Engineers has resulted in the reëlection of Mr. F. Collingwood, by the unprecedentedly large vote of 501 to 339. His opponent, Mr. C. W. Hunt, has for some two years served most efficiently as assistant secretary. Mr. Collingwood's handsome majority over his very able and popular assistant, who had, moreover, the advantage of being the candidate of the nominating committee, is a fitting acknowledgment by the Society of the fidelity and efficiency with which Mr. Collingwood had discharged his arduous duties during the three years of his incumbency. That gentleman has very generously signalized his reëlection by presenting to the Society a bond for $1000, the interest of which is to be applied to the payment of premiums for papers presented by Juniors of the Society, his very commendable object being to encourage a wider participation of the Junior class in the activities of the Society.

A commission appointed in May, 1890, by the French minister of public works to study the subject of curve resistance, has made its report. Their principal experiments were made upon a specially constructed experimental kite-shaped track at Noisy-le-Sec, on the Eastern railway. The dynamometric pendulum of M. Desdouits was used for recording the accelerations and retardations of the vehicles, from which the resistances were readily deduced. The track contained curves of 100, 150, and 200 meters (328, 492, and 656 feet) respectively. No increase of curve resistance with velocity was noted, up to velocities of 45 kilometers (27 miles) per hour, which is about the maximum velocity used upon the system. It was found that tight couplings gave the least resistance, and (as might have been expected) that considerable reduction of resistance followed the introduction of parabolic transition curves and the superelevation of the outer rail.

THE General Direction of the Austrian State railways has recently been erecting some remarkable stone bridges in the steep and rocky valley of the river Pruth, in Galicia, on the northeastern slope of the Carpathians. One of these, with a span of 213 feet, is exceeded in this respect only by the famous Cabin John (aqueduct) bridge near Washington, with its span of 220 feet, and is believed to have a greater span than any other stone railway bridge in the world. Nevertheless, the engineers confidently announce their conviction that in the near future even this great span will be thrown into the shade by greater ones.

IN the work on the Delaware Breakwater, at the mouth of Delaware bay, Major Raymond has been carrying out some interesting experiments upon the angle of slope of broken stone deposited at random under water. In constructing a dike to connect the ice-breaker with the breakwater proper, he departed from the usual practice of first depositing the stone over the entire width of the base of the structure, and confined the scow, from which the stone was dumped, in such a way that all the dumping was done within the width of forty feet, which is the top width of the dike to be built. The resulting slopes were carefully measured and it was found that upon the harbor or up-stream side the slope was 1 in 1.3, while upon the outer or seaward side the slope was 1 in 2. The latter is so remarkably steep, in view of the action of the sea-waves, that further developments will be awaited before proceeding with construction based upon it, but the inner slope of 1 to 1.3 is found to correspond very well with that of other works. It is therefore proposed to proceed at once with the construction of a wall built upon that side of the dike.

AT a recent meeting of the American Society of Civil Engineers, Mr. C. Robert Grimm, late engineer for the Tacony Iron and Metal Company, and the designer of the iron superstructure erected by that company for the tower of the new Philadelphia City Hall, gave a description of this work, the lower, or prismatic, portion of which has been in place for a year or more, while the pyramid which is to surmount it still stands in the yard of the builders at Tacony, no doubt pending the final settlement of the dispute, now before the supreme court, between the city authorities and the building Commission, as to the jurisdiction of the building. The iron work, comprising the octagonal prism and pyramid already referred to, consists only of upright and inclined rafters, braced by internal octagonal rings and braces in horizontal planes, and without trusses properly so-called.

"FLIEGENDE BLAETTER," the German comic paper, has a highly humorous illustration, showing a suggested utilization of a sawfish as a sawing-machine for cutting off logs under water. The log shown is horizontal, but after reaching so high a degree of perfection in the training of animals, it would surely be a small matter to induce the fish to work lying on his side, so that the method could be applied to the cutting-off of piles.

AMONG the minor exhibits of engineering interest at Chicago, and one from a part of the world and from an age where we do not ordinarily look for such items, was a model of a cantilever bridge of 161 feet span, at Amioto, Japan, built in 1662.

MINING & METALLURGY

Conducted by Albert Williams, Jr.

ALMOST every newspaper in Colorado makes an attempt at the close of the year to figure up the State's bullion output. There seems to be a competition between the several papers, each attempting to run up the totals a little higher than its rivals dare aspire to; to which motive must be added that of local State pride. It is an interesting study in statistics to compare the figures presented. One Denver daily foots up the total value of the silver, gold, lead, and copper produced in Colorado in 1893 at $30,000,000; another makes it $31,600,000; a third climbs up to $46,000,000. This Department has no means of ascertaining which is the nearest to the truth. Mr. W. C. Wynkoop, editor of the weekly *Mining Industry* (Denver), has kindly furnished an advance statement which will come very close to the actual total, the compilation including all sources except a return from one smelter for which the discrimination between Colorado domestic ores and imported ores is in doubt. The figures stand as follows:

Silver, troy ounces...........	27,610,492
Gold, troy ounces............	355,300
Lead, tons of 2000 pounds....	59,882
Copper, pounds avoirdupois...	7,502,765

The average valuation for the year would be: Silver, 77 cents per ounce; gold at the standard coining rate, $20.67; lead, $72.30 a ton; copper, 10 cents a pound, making:

	Market price.
Silver......................	$18,327,344
Gold........................	7,364,721
Lead.......................	149,115
Copper................. ..	75,028
Total...............	$25,916,208

This is a very unexpected showing, considering the depression in the silver and silver-lead industry during the latter half of the year.

THE suspension for one year of the operation of that provision of the United States mining law which requires $100 worth of work to be performed annually upon each mining claim is generally approved of, and of course by the owners of such claims. It is intended as a measure of temporary relief, and may or may not be made perpetual at the conclusion of the one-year term. In the present depressed condition of the silver industry, taking off the $100 "assessment-work" requirement is doubtless commendable, as the majority of the locators and holders of mining claims are poor men. It may be remarked in passing, however, that this assessment-work business has often complicated the question of titles, owing to the irregular and lax way in which the law has been complied with, the performance frequently being simply a farce. But the expediency of permanently annulling the requirement is much to be doubted. The object of the law, of course, is to prevent a single person from monopolizing a large number of claims, or even holding a single one, and allowing them or it to remain idle. The United States law of 1872, with all its manifest defects, certainly does not err on the side of illiberality to the discoverer or holder of mining ground. Indeed, it is far more liberal than that of any other country. The assessment-work feature, with others, was derived from the mining laws of Mexico. The policies of the two countries, however, are not wholly alike. In Mexico, where it was not expected that many new locations would be made, but where an immense amount of known mineral ground was already located, the object has been to compel, so far as law could effect it, the mines to be worked, in order that the country as a whole might gain by the increased yield of its most valuable product. Hence the law there is pretty stiff. In the United States, on the other hand, at the time our mining law was framed there was an immense area of practically unexplored country which it was desirable to open as rapidly as possible, and hence there was reason for holding out every inducement to the prospector and miner. At present our law does not fit the conditions and is generally disapproved by mining men. It must in time inevitably give way to a simpler, more rational system. As to the assessment-work clause, it is well enough to suspend it under existing circumstances.

An example of remarkably good tunnel-driving is furnished by recent records of the Palisades railway tunnel on the New Jersey side of the Hudson river. This tunnel is the most important railway-tunnel enterprise now under way in America, considerably exceeding in dimensions the Busk-Iranhoe, which has just pierced a divide of the Rocky mountains in Lake and Pitkin counties, Colorado. The work is being done by the New York, Susquehanna, and Western Railroad Co., for the purpose of giving their road a New York terminal. The contractors expect to "hole" the work about the time this notice will be read. They have been at work about a year. For the following data this Department is indebted to the courtesy of Mr. William L. Saunders, of New York. The tunnel is about a mile in length and is being driven through the hardest kind of Jersey trap-rock. The dimensions are 27 feet wide by 21 feet high. Mr. P. F. McLaughlin, who has charge of the east end, after careful experiment, has adopted the single-shift plan of drilling and blasting. Headings are usually driven by machine-drills placed on columns,—commonly two columns in each heading and from one to two drills on each column. It is usual to work day and night,—that is, two shifts per 24 hours. In view of the fact that after each blast quantities of broken stone are thrown about the heading, considerable time elapses before this muck can be cleared away, so that the drills can be mounted and properly worked. The result of this is that high-priced men, like drill-runners, do a good deal of mucking and several hours sometimes elapse before the drills have been properly put to work. Mr. McLaughlin's plan has been to economize in the cost of driving by running the drills during one shift per 24 hours, blasting at the end of this shift, and then employing common muckers to clear away the heading and to prepare, under the direction of the foreman, the columns and drills so that when the drillers come to work they immediately take charge of the machines and begin the work of drilling. With this plan Mr. McLaughlin succeeded during November in making a record of 161 feet of clear heading and 186 feet of bench. This work was done with four Ingersoll-Sergeant F-2 drills in the heading and six on the bench.

As compiled by the *Iron Trade Review* the total lake shipments of iron-ore during the season of 1893 were 5,836,749 long tons, as compared with 8,345,313 tons in the corresponding period of 1892, with 6,444,440 tons in 1891, and with 8,063,067 in 1890. Meanwhile the stock of ore on dock at the lower lake ports December 1 reached 4,070,710 tons, or about the same as in the preceding year at the same date. Taking these figures together, in the light of the extreme depression in iron production during the last half of 1893, the showing for the lake ore production is larger than might have been expected. It is supposed that the all-rail shipments of Lake Superior ore to the close of the year brought the aggregate to nearly 6.500,000 tons. The statistics of the Lake Superior iron-ore region for the last eleven years present a history of extraordinarily extensive mineral resources and of enthusiastic —perhaps too enthusiastic—development of them. The *Iron Trade Review* considers that, while only conjecture can estimate the iron-ore output for the current year, the position of stocks on dock is much more favorable than last year, since the stocks on hand at furnace have been so greatly reduced of late months. The outlook for iron-ore mining in 1894 is still a critical one, dependent, as is the whole iron and steel trade, upon the general business and financial condition.

THE coke trade is reported by the *Colliery Engineer* to be in a deplorable condition. Shipments are slowly increasing, but prices are being cut on all sides and coke is selling at ruinously low prices. More ovens are in blast in the Connellsville region than in the autumn, and sales have increased, but this is due more to the fact that coke consumers are taking advantage of the extremely low prices than to any legitimate demand for consumption.

SPECIMENS of ozocerite, the so-called mineral wax or native paraffin, have been frequently found on the Pacific coast, in the neighborhood of Puget sound and along the Columbia river. The source is now believed to be in the lignite-beds of the region, and the present value of the mineral warrants careful exploration. The demand, principally for making the insulating material okonite and for varnish, has caused the importation of Galician ozocerite to the amount of over a million pounds yearly. In this country a small but increasing quantity is obtained from the deposits near Thistle, Utah, the yearly output ranging between 50,000 and 100,000 pounds, though in 1890 a yield of 350,000 pounds was reported. The price, $100 to $150 a ton, would permit it to be profitably shipped from any point in the United States where it may be found in quantity to the eastern market.

IT is expected that the opening of the coking-coal fields of Sonora will not only stimulate the smelting industry of Mexico, in the branches of lead-, copper-, and iron-smelting, but help the business of copper-smelting in Arizona, and perhaps build up a large silver-lead smelting industry there provided the market for silver and lead improves. Newspaper reports state that Arizona copper companies are figuring on getting Sonora coke at $6 to $8 per ton on outside figures.

TAMARACK NO. 3 shaft, Keweenaw Point, Michigan, was down 3640 feet vertically on December 1, 1893. At the average rate of sinking, 75 feet per month, it had reached a depth more than 3700 feet at the beginning of the year, making it the deepest metal mile in the world, though, according to the *Engineering and Mining Journal*, there is a Belgian coal-mine for which a vertical depth of 3900 feet is claimed. The Yellow Jacket shaft, on the Comstock lode, Nevada, was sunk to 3040 feet. From the deepest levels of the Comstock some winzes were put down to still greater depths. These are all now under water, however. The Maria shaft at Przibram, Austria, was 3675 feet deep at the time of the great fire in the mine in 1892, since which time it has not advanced. The Adelbert shaft, in Germany, was the object of a popular demonstration and festival when it acquired a depth of 1000 meters (3281 feet). But the Tamarack No. 3, in the copper region of the upper peninsula of Michigan, appears to hold the record for deep metal mines.

AN engineer who is very familiar with the ground writes over the signature of "Inquirer" to the *Engineering and Mining Journal* a criticism on the management of the Tamarack copper mining company, of Michigan, which calls up an old and much-vexed controversy, namely, the question of policy in opening mines of rather flat dip—in this case 38° to 39°—from the horizontal. The point at issue is stated in the caption of the letter: "inclines on the vein [bed] versus vertical shafts and crosscuts." The Tamarack differs from mines located under the United States law of 1872,—commonly known as the rule of the apex,—in that it has no apex, being held under the Michigan law of "square locations," by which is meant that mining ground is owned on the same principle as other real estate. In other words, the holder can follow his vein or bed down to any depth at which end and side lines extend in vertical planes, but is prohibited from going beyond his side lines. This law, by the way, is the sensible, logical one, for it places titles on a sound basis,—that of surveyors' measurement, which can always be verified. The Tamarack adjoins the Calumet and Hecla ground, but to reach the ore-bed required a very deep vertical shaft, or else some arrangement with the Calumet and Hecla people to reach the ground of the Tamarack through the workings of the former, or at least a site upon Calumet territory from which to sink an incline. The No. 1 Tamarack shaft was started near the boundary line, with the idea of tapping the ore-bed within reasonable depth, and as a sort of compromise between the proving of a theory and obtaining financial resources to cover tedious dead work, and to secure dividends within the shortest time. Up to last May the mine has paid $3,470,000, and from that point of view the investment was a decided success. Now that the theory (that the Calumet bed extended continuously into Tamarack ground) has been proved, one can see how a better policy could have been pursued. At the time, however, the enterprise was regarded as somewhat hazardous, and the boldness of the projector was looked upon with some disparagement. Before the work was undertaken Captain Daniels made a trip through the western mining districts, and what he saw there must have impressed him with the belief that vertical hoisting was the right thing. It is the same problem that has been fought over on the Comstock, where (the dip averaging about 40°) one row after another of vertical shafts was put down, the last but uncompleted shaft, the Forman, having been planned to tap the foot-wall (there is no hanging wall, only broken country) at about 4000 feet. Some of the vertical shafts, after passing through the lode, were continued as inclines with round, separate cables and giraffes, but at great disadvantages. But the Comstock is an exceptional case. There is little motive for close figuring where the conditions are a huge gamble as to ore, as to water, and as to the inclination of stockholders to pay Irish dividends. Tamarack has been obliged to follow the same example, though from different reasons. No. 1 shaft cut the bed, when long cross-cuts became necessary. The requirements called for a second and a third shaft. Now "Inquirer" complains of the long cross-cutting and the extra cost of haulage. His remedy is an alternative one: either "install an electric underground plant for the long trams on the vein and to No. 1 shaft; and, second and more important, change the course of No. 2 shaft before it is too late to be of commercial value to the mine, so that these increasing tramming distances may avoided by having the shaft underlie the vein, or run in it, if practicable." The former proposition is most commendable; or a substitute might be suggested in a wire-rope transmission from the surface. But to alter a vertical shaft to an incline, putting in an elbow as it were, has been proved to be a most awkward arrangement. William Patton, a mechanical engineer before becoming a miner, who was superintendent of the Consolidated Virginia-California-Ophir group, and later of the Broken Hill Proprietary (of Australia), speaking to the writer of the Sutro tunnel, summed up the question between vertical hoisting and pushing cars by saying that he would rather hoist 1000 feet than wheel 2000 feet. Applying this dictum to the case of inclines versus downright shafts, the latter would have the advantage. "Inquirer's" objection would not hold if an improved system of underground haulage were put in the Tamarack. Of course if one could only see ahead far enough and had plenty of money to spend in dead work, he would plan a completed mine, as it would appear after the lowest depth and the longest drift had been attained, after the ore had given out, or the company had failed. But this is just what cannot be done, and it is one of the inevitable and regrettable drawbacks of mining that hindsight comes too late.

Among the noteworthy mineral resources of Minnesota are the large deposits of red and brown mineral paint (hematite and limonite) along the banks of the Minnesota river. This material was mined and utilized so long ago as 1867, though on a small scale only, and now renewed interest is being taken in its development. The ochers, umbers, siennas, and "metallic" paints annually mined in the United States amount to from 40,000 to 50,000 tons, worth, crude, over half a million dollars. They are produced in very many districts over a wide geographical range, and still hold their own in popularity on account of cheapness and durability. There are doubtless many deposits of red and brown iron-ores, manganese-ores, high colored shale and slate, soapstone, etc., now not utilized, which might be availed of in the manufacture of natural pigments. At present the greater part of the product comes from Pennsylvania, New York, Maryland, New Jersey, Virginia, Tennessee, and Wisconsin.

In regard to the supposed lost art of hardening copper, referred to by Mr. Pentz in the November issue of this Magazine (page 256), attention may be called to one case about which there has been much needless controversy. The copper implements left by the ancient miners of the Lake Superior copper region have been claimed to have been hardened by some unknown process. These relics, of which the most important are hatchets or adzes, certainly were nearly all, and perhaps all, hammered out from pieces of native copper, and the makers of them were presumably ignorant of the art of casting, still less of alloying; though some aboriginal copper adzes in the Smithsonian collection look as though they might have been cast, as it would seem difficult to produce the shapes by hammering. Besides, this native copper is exceptionally pure. While there was no sufficient basis in fact on which to found an argument in favor of the lost-art theory,—for the few specimens are entirely too valuable to use up in testing,—an explanation which seems to be a reasonable one is that the copper has become hard superficially, just to the depth of the thin film of alteration that has in the course of time formed upon it. Along the cutting edge of a hatchet, for instance, there does seem to be a sharpness and hardness not natural to pure copper; but on close inspection the edge is seen to have a coating of some secondary mineral, perhaps a silicate, having a greater hardness than pure copper. Ancient copper tools and weapons from other regions, that plainly were cast, and which contain small percentages of other metals (mainly tin or iron), but not enough to constitute a regular bronze, are very likely to have been accidental alloys, not intentional ones. This could easily happen (in fact it would be strange if it did not) because of impurities in the ores, which impurities were about as likely to act favorably as unfavorably. It required considerable technical skill to make a true bronze.

A chemist who has made a special study of the composition of ancient copper and bronze implements, and to whom this question of the mythical lost art of hardening copper was referred, favors this Department with the following notes: "Some native coppers contain small quantities of iron tin, etc., which would make them harder; but the notion of an unknown method of hardening probably arose from a wish to explain the sculpturing on the monuments in South and Central America, as there were no iron tools there. Now we know that these stones could have been cut by stone implements without the use of metal tools. Mr. J. D. McGuire has succeeded in making a number of similar objects by means of other stones, has bored holes in them with wood and sand, etc., and says that monumental sculpture could be easily done with stone tools by pecking. The copper spearheads, knives, and what not in the Smithsonian museum have a film or coating of green carbonate (?), and apparently a little red oxid, which can be rubbed off."

It is stated that Mexico's largest gold nugget weighed 14½ pounds. It is not a little remarkable that on the North American continent, notwithstanding the enormous total output, the nuggets as a rule have ranged so much lower than in Australia. In the "pocket" mines of California, and in various "specimen" mines of Colorado, Idaho, and Montana, some wonderful nests of native metal have been found, but neither in them nor in the placers anything to compare with the famous "Welcome" and other historical Australian nuggets.

ANOTHER device for finding metallic ores underground is reported. The description published is that "it consists essentially of a coil of insulated No. 18 wire in circuit with a battery and an interrupter. At an angle to this coil is another of fine No. 36 insulated wire in circuit with a telephone which the prospector applies to his ear while holding the coils over the ground." The account goes on to say that "if there is no mass of metal or magnetic ore present the telephone is silent,"—a statement easy to believe, in the absence of any outside cause,—"but if there be, the interruption of the current can be heard by the corresponding currents induced in the telephone." Attempts in this direction have been made from time to time by many hopeful inventors to find mines and reveal buried treasure, but we have not heard of any successful results being attained, though the newspapers often contain glowing promises of what is going to be done. These efforts always remind one of the attempt made by two eminent scientists to locate, by means of the induction coil, the leaden bullet that killed President Garfield. In that case it happened that a woven steel-wire bed was present to vitiate results. So in mines also there are interfering agencies. The novelty of this last reported prospecting invention consists in the application of the telephone. But a series of very carefully conducted experiments, with apparatus of the most refined delicacy, was made in 1880–81 by Dr. Carl Barus on the Comstock lode and at Eureka, in the neighborhood of known and large ore bodies, and the results were negative. An account of these interesting experiments is given in Mr. G. F. Becker's report on the Comstock lode, a monograph of the United States Geological Survey.

AT a Swedish iron-works a method of consolidating steel ingots by the pressure developed by centrifugal force has been in use for two years, and, it is said, successfully; though from the published description it would appear to be applicable only to comparatively small castings. From an account published in the *Industrial World* (Chicago) it is learned that "the apparatus consists of an upright shaft in the center of a cylindrical casting-pit, carrying a frame of four arms, to each of which is jointed a platform supporting four ingot molds. While the shaft is at rest the molds are upright and are filled in the usual way; but when it is set in rapid rotation they fly up into a horizontal position and a pressure is developed in the length of the ingot equal to thirty times that due to the column of liquid metal in the mold, which drives the gases out and," the *Industrial World* reports, "produces a perfectly solid casting." The method is certainly an ingenious one, but it hardly promises to solve the great problem of the day in steel metallurgy, which is to produce sound, solid castings of the sizes needed for armor-plates, propeller-shafts, etc., that will not require forging by the steam-hammer or hydraulic press, but be made at a single operation and need only the application of a finishing tool. The solution of this problem is one of the things that conservative metallurgists deem to be among the impossibilities and that enthusiasts believe are going to be accomplished some time in the indefinite future. If the latter view proves to be the correct one, the result will probably be attained by the introduction of untried alloys and by small changes in the composition of the metal; that is, by chemical rather than by mechanical means. And if such a thing is possible on the large scale it would not only do away with elaborate complication of built-up ordnance and similar expedients, but also with the heaviest and most expensive machinery of existing steel-plants.

MACHINE SHOP PRACTICE

Conducted by Albert D. Pentz.

MR. JOHN RICHARDS writes in *Industry* (San Francisco) for December:

Mr. A. D. Pentz, in the section on Machine-Shop Practice in THE ENGINEERING MAGAZINE for November, complains of sockets to hold machine-drills, and with reason, but he is wrong in assuming there are no good "chucks" of the kind. We once made a drilling-machine, not a "press," for Mr. Wilson, of the Southern Pacific Railway Co., provided with sockets to receive shanks not less than one inch in diameter, the socket portion slightly tapered, flattened on one side to receive a through key mortised through at one side of the bore. The sockets fitted into the spindle in the same manner with a diameter of one and one-half inches or more. The machine has been in use eight years, and we much doubt if ever there has been a failure of its sockets or of the drill-shanks. Size is the main thing. If it were not for expense the square shanks of our forefathers are the best of all.

Now we did not complain of sockets at all, because there is practically no complaint to be made of them. But we did complain of chucks, which are very different things, and which continue to deserve criticism in the particulars specified. There are no good chucks for drill-presses. We do not say that there is no effort made to produce good chucks, because we do know there is a constant endeavor made to get what is wanted. Taper-shanks on drills make them expensive and it takes more time to handle such drills than it does to handle those with straight shanks in compressible chucks. The latter, therefore, are preferred by those who use them in manufacturing for profit. The means mentioned by Mr. Richards seems to be a good one, and we are glad to copy his description of it, but it would not answer in places where a rapid exchange of drills of different sizes is necessary. The square shanks of our forefathers are certainly and happily relegated to the past,—to the time when there was no great need of truth in the movement of drills or of an accuracy to the one-thousandth of an inch in the sizes of holes to be drilled.

A SECTION through, in a drawing, will tell more about the arrangement of the internal details than dotted lines ordinarily can. Therefore, after a sufficient number of side views and a plan have been made,—or, better, an isometrical picture of the device illustrated,—enough cuts should be made through different parts of it to clearly show the inside parts. This practice generally will obviate the necessity for a separate drawing of the full details on experimental work and on tools, where it will be found necessary to draw but few such details of the more complicated shapes. Dotted lines for every covered part are an abomination when made by the average draftsman. Few men have the artistic skill thus to depict the transparent effects so that an intelligent view is given of the internal parts. A section here and there, on the other hand, makes all parts clear and so well within the capacity of the most ordinary draftsman to depict, and in the power of the most crude mechanic to read, that there can be no two opinions as to the advisability of plenty of sections and few or no dotted lines. In a long experience we have found it to pay, as a corrective, to make sections, for many of the mistakes of draftsmen may thus be caught and remedied.

ABOUT one business concern in twenty that starts to build machinery succeeds; the remainder fail or change in shape so as to oust the original projectors. Let us consider the causes of such failures as they have come within our observation. A frequent cause is bad faith somewhere. Two mechanics, say, save some money and set up for themselves. One of them will at once begin to try to get the control and the other will refuse to submit. The end of such a concern is certain, for no man with self-respect will or can work with another whom he cannot trust. Or an inventor contracts with a capitalist, one furnishing a valuable device to manufacture, the other agreeing to furnish the money. It succeeds, or looks as if it would; then the one most greedy seeks to squeeze the other out and the one who can stand the strain longest gets possession of the business. In neither of these two cases can there be a lasting success for the survivor, because as soon as the schemer gets rid of the worker it stands to reason that nothing can be then produced under commercial conditions. These costly experiments must fail, and they should fail, for no man can keep good faith with his customers who defrauds his colleagues in business. Again, bad faith often exists, where an inventor deceives capital, either as to the value of his device or as to his title to the property in it. In such a case the trouble is short-lived ordinarily, for as soon as the goods reach the market the fraud will be exposed.

SOMETIMES a business is started with the purpose and the expectation of ultimate failure. Thus a pseudo-inventor devises a machine to make a valuable product, which product in itself has been patented by some one else. The machine itself may be new and patentable and, as such, stand the most searching examination. It then is made the nucleus of a stock company by its unscrupulous promoters, and those in the game divide the stock among themselves. Then they start, with a great deal of noise, a "boom," to get people with money interested in it. If this succeeds the stock is quietly unloaded on new buyers until the inventor (? and the promoter have none of it left, and then of course they have no further interest in the concern. The new buyers start a factory in the confidence of making money by underselling the older concern, which owns the patents on the product of both the old and the new machines. When, however, the factory has been built at a large cost and equipped at a much larger cost, and when the machines come out and go to buyers, an injunction will lift its horrid head and crush the life out of the whole business. This game, with infinite variations, is worked continually. If it succeeds it fattens the rogues who engineer it and if it fails there is little lost.

BY far the greater number of failures in the manufacturing business is due to lack of resources. Money and credit are gone before the business is made to pay its way. This is to be regretted, because often every other element of success except money is present in the enterprise.

SOMETIMES a person embarks in a business which his training has not fitted him to manage, and if he is stubborn, or not inclined to take the advice of the initiated, he certainly will fail. We once knew of a business owned by a retired country banker, who managed it himself. The machinery he made was modern and good and could be made and sold at a large profit. But this man's method of doing business was too severe. His correspondence was of such a nature as to imply doubt of every statement made by a buyer who was not prepared to pay cash in full for his purchase. In cases where notes were taken in part payment he would attempt usury. Thus those who might have bought his tools found it more comfortable to do without them, though by going elsewhere they bought an inferior article.

THE chances for successfully starting a small business on small means are growing narrower every decade. In fact, the best advice for an ambitious aspirant to a business for himself is "don't." We know, however, that there are men whose mettle disdains advice, who think for themselves, who can go into business against all odds and succeed to their great glory and renown.

THERE is a way in which to do every

desirable thing. The knowledge of how to do difficult things by simple means is art. For many years we sought for a means to mark oilstones, that is, to place upon them indelibly the names or the initials of their owners so that they could be identified and returned if they accidentally might be found by another fellow in his tool-chest. At last the way to do this was found accidentally. In looking over a box of fine Arkansas stones a little ticket was found, bearing the cost-mark pasted on to one of them. This did not teach anything, but the stone next to it in the box revealed the whole secret. The ticket had been written upon after it had been pasted to the stone, and then it was put into the box with the wet ink in contact with another oilstone. Part of this ink was absorbed by the dry clean stone, as if by a blotter. A moment's examination showed that the color had pentrated deeply into the porous stone. All oilstones necessarily are porous, and colored fluids like ink will penetrate them deeply when they are clean and new. In marking a stone one should use a fine-pointed pen so as to make clear, sharp lines, because the ink will spread to some degree and if the name be written with heavy lines, or in too small characters, the reading of it will not be clear. We would advise that the name be written over the whole broad side of the stone and in very large characters. Such a stone can be used to whet tools ten minutes after it is marked, and it will be worn out before the markings disappear.

We have been particular in this description to give the details of the finding of this simple and practical means to do a desirable thing well, which thing seemed to us quite difficult before that time, and we wish in this connection to emphasize the value of the habit of considering whether unusual phenomena may or may not have a practical application to the arts. Such simple discoveries as this should be considered with as much care as those that seem at first to be of greater magnitude. When an unusual effect comes to the notice of the writer he considers it from two standpoints, which may be indicated by the two questions: Is this phenomenon needed in any art, and will it do better work than has been done by older means before, or does it do something that has not been done before? Can this new effect be made the nucleus of a valuable new art? Great arts, such as that embodied in the telephone, are seldom born, but every new discovery has in it the possibility of as great an art, if one could but recognize its application to human needs.

After considerable personal experience in the matter, and more of the experience of others of greater familiarity with the subject, we are of the opinion that electric lights of the arc variety are not under any circumstances to be advised for machine-shops. This light is too bright at close quarters. It is too direct and straight. It casts too deep shadows. The great contrast between the fierce light and the black shadows distorts all objects and affects the judgment of workmen in relation to sizes and distances. And it hurts the eyes of the men, perhaps in a short time ruining the sight. Apart from the novelty there is not much to recommend this light. On the contrary, a sufficiency of low-candle-power incandescent lamps well distributed, so as to make a simulated daylight, is a glorious light with none of the objections that condemn the arc lamps. But they are more expensive.

In the machine-shop a very coarse and hard grindstone is better than any other combination whatever. Since all machine-tools are, or should be, whetted upon an oilstone before use, the edge made by the coarse stone is not important. The coarse stone will cut faster and last longer than the fine one, and of course it is the more economical. Planer-tools should be ground upon a large stone, as small wheels make them too concave for good service. In fact, if planer-tools were not concave at all they would be better for it. Of course the oilstone corrects the concave effect to a minute extent, but it makes no addition to the durability or strength of the edge in the direction of the thrust when at work. Lathe-tools, on the contrary, are rather improved by being ground concave, because a somewhat stronger point may thus be gained.

IT is doubtful whether the points of turning-tools, or of any other similar cutting-edges for metal, are improved by sharpening them to an angle more acute than fifty degrees. It is certain that all cutting-tools should have not more than five degrees of clearance between the cut and the tool. Hence a planer-tool should have about five degrees' rise, but the workman should be careful not to reduce this in whetting. If lathe-tools were made like planer-tools, and lathes were made to accommodate them, so that the cutting point or edge should be center high only, they would be greatly simplified and more uniform as to their angles. Now some tools are placed at the center—for instance, a side tool or a thread tool. Another is lifted twenty degrees or more above the center. This requires a close adjustment of the tool-post, which sometimes is got at the sacrifice of part of a lathe's capacity. Perhaps this difficulty may be remedied some time by the invention of an inserted tool of simple design, but such a tool is not yet accomplished.

IT is a fact that a ray of light is one of the most unreliable of straight edges in a room lighted from gas-jets, or any other means which provides light from heat or from various points. Light is bent around in curves by many causes as easily and as generally as a flexible spring. Guilemin shows clearly that the disk of the sun is seen for some time after it actually is below the horizon, or set. Any one can see a bright line on the dark edge of a new moon and this means that light is bent over the moon and conveyed around a corner from the sun to the eye that beholds it. In any room where machinery can comfortably be made, the density of the air varies from a great many such causes as artificial heat, motion in machinery, openings such as doors and windows which make currents of air, and the animal heat of workmen's bodies. Hence the light passing through air at differing densities is bent or refracted considerably. Fine workmen in fact do not use light at all to determine straightness. They depend entirely on the sense of touch and on the touch or contact of the part being tested with a straight edge or plane surface. Of course, wherever an absolutely straight and sharp edge shuts out light along a line, that line is absolutely straight if it be situated where light exists to be shut out. However, that is not the condition in question, which is that a line can be found to be straight or crooked by the eye looking along it. It cannot be so found within limits sufficiently accurate for any kind of fine machinery.

THE paper test is a much more reliable one than the light test for the rougher work. The straight edge used should be a parallel one sufficiently wide in relation to its length and rigid so that it may not sag perceptibly over low places. Smooth tracing paper is the best, as it is of uniform thickness and tough. Cut, do not tear them off, strips of paper from a single sheet one-quarter inch wide and two inches long. Place three at least of these pieces of paper at the required intervals across the line to be inspected and place the straight edge upon them. Of course a piece of the paper that may be found loose indicates a low spot, and a very tight one a high spot. If all are tight alike the line is stright if the test edge is. It is obvious, if the straight edge is parallel, and the same result is obtained on both its edges, that its straightness is assured.

SOME workmen make their positions a great deal harder than is necessary. The moment they receive an order or a request to do work in a certain way they at once want to do it in some other way, or want to do some other thing. Now a live manager always is alive to suggestions that may lead to improvement, and is glad to get them, but forever to be met with opposisition is one of the most disagreeable things in managing some otherwise valuable men. We know of many men who have no other fault than this one, which sets upon their efforts so heavily as to prevent them from rising above subordinate positions. Again, other workmen are too willing to do all they are ordered to do,—so willing, in fact, that they frequently give their managers the idea that they either do not think about their work at all, or that they are anxious to avoid all responsibility and are lying in wait for an opportunity to perform an operation according to instructions that shall be wrong. This quality of man never rises by his own exertions and seldom by those of others.

ANOTHER fault, and a most un-American one, is that of keeping the processes and details of work a secret from others. This fault is the error that seems to sustain a great many labor societies and makes them engines of injustice where otherwise they could be mighty forces in civilized advancement. What movement leading toward higher wages was ever advanced by trying to corner all knowledge of the art the movement sought to control? In thirty years of experience in the machine business we have seen this error attempted at least as many times, and we are glad to record that failure has followed each attempt to place a tax upon free knowledge.

It seems to us peculiar that generally in machine-tools some essential things and some conveniences will be striven for in the design and got perhaps at the sacrifice of strength or of symmetry, while other things as essential are quite neglected or got in a perfunctory manner without care or inspection. Thus iron planers have two screws to elevate and adjust the rail. These screws may be one a right-hand screw and one a left-hand screw, or both may be of the same kind. They are geared on their upper ends and connected together by a shaft so that both are turned together and raise both ends of the rail simultaneously. Now either there is no great effort made to make these screws lead exactly alike, or the problem is one of considerable difficulty. We believe the latter to be the fact where the screws are right and left, because few lathes cut left-hand screws of exactly the same lead in every part of their lengths as they do right-hand ones. In some planers the lift on one end of the rails is faster than the other, to such an extent that in elevating one foot it is raised higher than the other by three-thousandths of one inch. And it is high-class planers of which we speak. Now this variation is fatal to modern good workmanship and behind the age.

One maker tried to make us believe that this variation was due to the torsion in the shaft connecting the two screws. It was found that this, in a planer inspected, was not the case, but had it been the case it would not have been the remedy, but an explanation of a defect not overcome.

No one appreciates more than we the difficulties in making two screws exactly alike. But no one prescribes screws, for other mechanical devices, such as racks and pinions, or cylinders and metal bands, would serve, and perhaps better. Two racks cut together can be made without sensible variation the one from the other; so can two pinions. Now if these be mounted as they are cut, tooth opposite tooth, on each housing and in the rail, there certainly can be a gear mounted on the pinion-shaft, midway between, that should minimize the torsion to so small a fraction that it could be neglected.

We do not forget for an instant that a careless workman often raises his rail without properly unclamping it; but we are not speaking of defective men, but of defects in tools. We know workmen who have a number of sets of posts, two to a set of exactly equal heights to adjust the rails of their planers upon, when they do particular work.

WHAT a blessing is a good casting. It is soft, so that the tools cut smooth and keep sharp. It is true to pattern, so that none but light cuts have to be made and it matches the seats it is to be bolted to. It is smooth and looks well painted or japanned, or it takes but little polishing to finish it. It is sound and has neither holes in it, sunk spots on its surface, nor "cold shuts" to mar and make it weak. Its cored holes are properly located and smooth.

CURRENT TECHNICAL LITERATURE

THE CONSTRUCTOR: A HANDBOOK OF MACHINE-DESIGN. By F. Reuleaux. Translated from the Fourth Enlarged German Edition by Henry Harrison Suplee. Philadelphia: H. H. Suplee. [Cloth. 4to. xviii-312 pp. $7.50, by subscription.]

THE appearance of an English translation of Professor Reuleaux's famous "Konstrukteur," the work upon which his fame is largely based, and from which nearly every subsequent writer on the subject of machine-design has freely drawn, is worthy of extended notice. American and English engineers who have received a continental training, or who are at least familiar either with German or French, have long since adopted this standard work as an authority in the most practical departments of machine-design, and notwithstanding the inconvenience of using a work written in a foreign language, and expressed in the metric system of measurements, "Der Konstrukteur," of Professor Reuleaux, either in the original German or in the French translation, has found a place in many drawing-rooms of our larger machine-shops and manufacturing establishments.

The present work, however, enables every English-speaking designer, draftsman, and engineer to use the vast collection of data and information, not only in his own language, but also in the notation in which, probably for a long time, his computations must be made. The whole work has been both translated into English and also transformed into the English system of measurements, and for the first time the entire results of Professor Reuleaux's work are placed in the hands of what he himself has characterized as one of the most active and energetic races in the department of machine-construction.

Reuleaux's Constructor differs from most works on mechanical subjects in that it aims to present *results* rather than demonstrations, and, instead of filling the pages with elaborate calculations, the author has given the final results of the researches of practical and theoretical men in all branches of machine-design, in the form of tables, diagrams, or convenient formulæ, and in all cases the practical applications of the methods given are made clear by fully-worked examples showing plainly how the rules are applied and used.

The first section of this work consists of a thorough but condensed collection of data on the strength of materials, and contains tables and formulæ for proportioning all the different forms used in practice to resist the varied action of forces. In this section will be found discussions of bodies of uniform strength, of beams, columns, and vessels of various shapes, and also the proportions of hooped guns, together with a discussion of the proportions of springs. The second section contains the elements of graphostatics, and is the clearest and most compact presentation of this important subject which has yet been made.

The principal portion of the book consists of the third section, which treats of the construction of machine elements. This includes rules, formulæ, and tables for proportioning the various details of all kinds of machinery, so that by the use of the book the correct dimensions and proportions of every part can be obtained. This portion is based both on theoretical considerations and on practical results, and the extensive use by many well-known engineers of the rules and tables here given has proved their correctness and reliability. An idea of the fulness with which these details are discussed will be obtained from the following enumeration of subjects of several chapters: Riveting, hooping, keying, bolts and screws, journals, bearings, axles, shafting, couplings, simple levers, cranks, combined levers, connecting-rods, cross-heads, friction-wheels, toothed gearing, tension organs (including belting-, rope-, and chain-transmission), pressure organs (including pipes and conduits), reservoirs, and valves of all kinds. The higher mathematics are not used, and all the formulæ and tables are readily applied by any one having an ordinary mathematical education.

The last section of the book contains a collection of useful mathematical tables, showing, by means of illustrations, the various properties of the curves, surfaces, and volumes used in practice, and also some very convenient tables of numbers and angular functions. The work is copiously illustrated and very fully indexed, the index containing nearly 2500 entries.

The translation has been made by Mr. Henry Harrison Suplee, who is well known as an active member of the American Society of Mechanical Engineers, and we cannot better express our opinion of his share of the work than by giving here an extract from Professor Reuleaux's special introduction to the American edition, in which he says: "I take this opportunity to express my particular appreciation of the great care and extraordinary accuracy which he has displayed in the production of this English version, and also my gratification at the care which has been given to the printing and the reproduction of the illustrations. Mr. Suplee has recalculated and transformed all the formulæ and numerous tables into the English system of measurements, and also reworked all the examples, and has shown in this portion of the work a patience which deserves special recognition. I can only add that it is my earnest desire that the friendly acceptance of my book by English-speaking engineers may correspond to the magnitude of the labor which has been expended in the preparation of this translation."

THE INCANDESCENT LAMP AND ITS MANUFACTURE. By Gilbert S. Ram, A. I. E.E. Illustrated. London: "The Electrician." [Cloth. 8vo. 211 p. 7*s.* 6*d.*]

NOTWITHSTANDING that the incandescent lamp has been known for seventeen years, and been in more or less general use for about half that time, its manufacture has been so hedged about with secrecy that little has become known to the public as to the details of its making. In America the processes involved have become better generally known to the public than in England, by reason of a less vigorous prosecution of infringers by the Edison interests, and by the numerous lawsuits involving these processes through which they were necessarily made public. But while almost every step has thus been made public and has been described in our various technicals journals, until the appearance of this work there has not been published any comprehensive treatise on the subject, either in this country or in any other. The recent expiration of the Edison patents in England and their approaching expiration in this country render the present a most appropriate time for the appearance of such a work as the one under review.

Mr. Ram's work is the latest addition to "*The Electrician* series." It is uniform with the two works of J. A. Fleming on "The Alternate Current Transformer" and J. A. Ewing's "Magnetic Induction in Iron and Other Metals," and is mechanically all that is required. Mr. Ram's method of treatment is a logical one, beginning with the filament and following it up with the preparation of the filament, carbonization, mounting, flashing, sizes of filaments (unflashed), sizes of filaments (flashed), measuring the filaments, glass-making, glass-blowing, sealing-in, exhausting, testing, capping, efficiency and duration, and relation between light and power, to each of which he devotes a chapter.

Heretofore the stamp of "*The Electrician* series" has been the highest possible endorsement that an electrical book could bear, and the present work was taken up for review with prepossessions so highly in its favor that perhaps disappointment was inevitable, but that disappointment of the deepest kind followed connot be denied. To start out, Mr. Ram's style is jerky and apparently that of a novice. In the earlier chapters he frequently repeats himself in almost the same words, perhaps on the same page. In describing processes, such as that of carbonization he gives much space to description of a proper carbonizing furnace which would be much better described by the simple statement that it was a reverbatory furnace of given dimensions or proportions. And much of his descriptive matter relates to things or processes which cannot be described, but must be learned by actual practice. In fact, some of his attempts in this line are very like reading one's instrument finer than the instrumental error. This he frequently does. At times he treats his reader as the merest novice, and at others as an expert. Thus for the expert there is much given that is entirely superfluous, while for the novice there is much given that he cannot understand. But he might be forgiven all this if he were correct. Unfortunately he is often glaringly incorrect in his statements. Take the single chapter on "Preparation of the Filament" as an example. He describes the process of parchmentizing a cotton thread correctly, but all the other processes are wrongly described. He states that the cellulose may be dissolved in chloride of zinc, and the resulting viscous solution, after having been formed into a filament and hardened by squirting through a small hole into alcohol, used at once for the furnace. He says the same thing about what he calls "Crookes's process in which the solvent is cuprammonia." No one can make a filament that can be used in a lamp by either of these processes *as he describes them*. He omits the essential step in each, namely, that after the cellulose has been brought into solution by either of these processes, it must be precipitated again, thus getting rid of the zinc on the one hand and the copper on the other, which, if left in the filament, would render it absolutely worthless on carbonization. And in describing Edward Weston's process (the only one of this kind mentioned) he informs us that he converts the pyroxylin into the material known as *celluloid*. Mr. Weston never did such a thing except, perhaps, experimentally, but he does convert it into *collodion*, and it is not this that he "rolls out into thin sheets," but the reprecipitated *cellulose*, as in the other processes.

It is mistakes of this kind in the beginning of a book that cause the reader to lose all confidence in the author and to question everything else later. But he pulls himself together later on, where he is describing the practice of (presumably) the shop in which he was engaged. He is then apparently sure of his ground, and from Chapter V to the end has given us a very good book, replete with information that is interesting and good. That portion of the book which might be termed a description of his own shop-practice is beyond criticism and, if read as such, valuable.

NELSON W. PERRY.

NATIONAL CONSOLIDATION OF RAILWAYS. BY GEORGE H. LEWIS, M. A., of the Des Moines Bar. New York: Dodd, Mead & Co. [Cloth. 8vo. 325 p. $1.50.]

OUR railway problem is so vast, and of such importance to the whole nation, that any intelligent attempt to solve it is to be welcomed, even though not wholly successful. Mr. Lewis does not seem to have had experience in railway management, and is therefore and evidently unfamiliar with many of the perplexing questions which arise in actual practice, but he has given much reading and thought to the problem. Briefly stated, his theory is a compulsory consolidation of all the existing railways into a national company to be controlled by representatives of the present stockholders and bondholders, of the different States, and of the federal government. Present bonds and stocks would be merged into new capitalization on which the government should guarantee 3 per cent. All the difficulties enumerated in the first part of the book would be eliminated, Mr. Lewis thinks. Aside from the momentous constitutional questions involved in such a plan,—the author believes that Congress has such power,—and the further problem of taking the legal control away from the States, it is more than doubtful whether such a plan, if carried out, would have the good effects predicted for it. The wages question, for instance, would be intensified, for switchmen and train men would say that an advance in pay should be granted because dividends were guaranteed by the government. In like manner every farmer would expect to get lower rates. The inevitable and heavy deficit arising from the increase in operating expenses and the decrease in receipts would have to be met by general taxation.

Although Mr. Lewis believes that rates are a species of taxation, he would undoubtedly hold that taxes ought to be apportioned among those benefited. This cannot be done as to transportation in any way so well as by putting the cost of operating upon the things and persons carried, and not upon the community at large. The truth is that the theory that rates are taxation, while true in part, is liable to mislead. Railway rate-making is a commercial problem, a problem in most cases of prices at two different points, whose difference—profit—must be divided between shipper and carrier. The author mentions this, indeed, but gives little weight to it. The taxation theory is favored by the author principally because of the subtle inference that railways are public highways and therefore properly subject to government control alone. They are public bodies, and they are not. In this contradiction lies our difficulty. In one sense rates cannot be determined by scientific process any more than the price of beef or the butcher's profit. No government ownership could eliminate this commercial element. Are we not better off by allowing these commercial questions to be settled on commercial principles under private ownership? Yes, if concurrently we can also arrange to insist upon the undoubted rights of the public upon the railways. Of course we have not reached an adjustment of these two often conflicting principles of public right and private profit, but it is yet to be proved that government control would help us much.

Minor portions of the book deserve praise and criticism. Mr. Lewis' denunciation of stock-watering is strong, but not discriminating. There is innocent watering as well illegitimate. So it is confusing to find stocks referred to as a "debt" of the corporation (page 16). Again, an accurate analysis of expenses as relates to individual shipments or individual rates, cannot be had. Discriminations in rates—Mr. Lewis thinks—should be made against instead of in favor of towns having exceptional advantages, like water competition (page 94). Yes, perhaps, as as end to be reached in the future, for it is the business of railways to equalize such advantages and so permit the upbuilding of flourishing cities not on the great rivers and lakes; but until earnings permit of such a policy the company must get enough receipts to live on, even if rates be unequal. If government demands an opposite policy it must accept the responsibility and pay the losses incurred.

Mr. Lewis deserves thanks for the fairness which distinguishes his work. Discussion of this sort is always a help to a solution of our railway problem. T. L. G.

BRITISH RAILWAYS: THEIR PASSENGER SERVICES, ROLLING-STOCK, Locomotives, Gradients, and Express Speeds. By J. Pearson Pattinson. With plates. London: Cassell & Co., Limited. [Cloth. 8vo. 250 p.]

THIS work is written with the intention of discussing the subject of railway traveling from the public point of view. It is an inquiry into the accommodation afforded by the railway companies. The first part deals in a general manner with the subject of railway traveling in England and other countries, and comments on the train services, rolling-stock, safety appliances, speed, and punctuality, on English, continental, and American railroads. In the second volume particulars of the commercial speed of all the leading British lines are given, followed by a description of the locomotives used in express traffic, the gradients over which they run, and the actual work they perform. This is the first book on the subject ever issued in England, we are informed, in which the popular side of the question is treated at length.

A FIELD-BOOK FOR CIVIL ENGINEERS. By DANIEL CARHART, C. E., Dean and Professor of Civil Engineering, Western University of Pennsylvania. [Cloth. 32 mo. 282 p. $2.50.]

THIS book is written for students of civil engineering and meets the demand for a manual convenient in size, systematically arranged, illustrated, and easy of reference. It treats that part of the work of the civil engineer which will enable him to locate the center line of a railroad, set the stones, compute the quantities, and solve the problems pertaining to track-laying. The various subjects are introduced in the order in which they present themselves in actual work. The first two chapters deal with reconnaissance, preliminary survey, location, and the required instruments. In Chapters III and IV are derived numerous formulæ, and practical problems are proposed, their solutions also being indicated. The next chapter has a set of miscellaneous questions. In Chapter VI, which treats of construction, the difficulties of the young engineer are kept vividly in mind, and simplicity is constantly aimed at. The last chapter is on frogs and switches, and is from the pen of Lewis C. Weldin, assistant engineer Pennsylvania railroad. The book contains all the necessary tables for field use.

Ice-Making Machines. The Theory of the Action of the various forms of cold-producing or so-called ice-machines. Translated from the French of M. Ledoux, by J. E. Denton, D. S. Jacobus, and A. Riesenberger. New York: D. Van Nostrand Co. [32mo. 190 p. 50 cents.]

The new edition of the translation of M. Ledoux's valuable essay, which, as published in Van Nostrand's Science series, has proved a useful source of practical information and theoretical suggestion, is designed to make the work more available to American students. All figures have been transformed to English units, and all results expressed in the units commonly expressed in American practice. Footnotes have been liberally introduced to emphasize important points of the text, supply intermediate steps not fully indicated, and to call attention to modifications of the author's views necessitated by recent experience. There are other important additions which we have no space to mention in detail.

Industrial Arbitration and Conciliation. Some chapters from the industrial history of the past thirty years Compiled by Josephine Shaw Lowell. New York: G. P. Putnam's Sons.

The object of the compiler is to present an account of some of the methods by which industrial peace has been attained in many large industries, both in Europe and in America. The book comprises twelve chapters taken from books of different authors dealing with the subjects of arbitration, conciliation, and the trade-union movement in general. The compiler believes that labor organizations are not only inevitable in free countries, but highly beneficent. It is useless to attempt the arrest of the movement, and history shows that laws against such combinations only tended to make the unions lawless and violent. It is better for the employers and society as a whole that the unions should receive due recognition, and that disputes between the employers and their organized employés should be settled by resort to arbitration. The success of arbitration in England, Belgium, and the United States is amply shown by the facts set forth in the book. It is a mistake, however, to suppose that arbitration offers a permanent solution of the labor problem. For such a solution we must look into the principles of land tenure, finance, trade, and exchange.

Thr Philosophy of the Tool. By Dr. Paul Carus, Editor of the *Monist* and *Open Court*. A lecture delivered before the Department of Manual and Art Education of the World's Congress Auxiliary. Chicago: Open Court Publishing Co. [Paper. 24 p. 15 cents.]

Every one who handles and appreciates tools should read this interesting and philosophical disquisition. Dr. Carus's treatment invests the tool with a dignity and value to which many workers are unfortunately blind. Franklin, by his famous definition of man as a "tool-making animal," not only gave expression to the energetic spirit of American industry, according to the author, but gave a more profound definition of man than any other thinker, for he suggests that man's reason developed by the exercise of reason, that the organ was created by its functions, and that applied reason—work—has been the great educator of mankind. The contempt for the mechanical is irrational, and has been due to a mistaken view of the tool. The tool is not passive; it corresponds to the creative principle. The mechanical is mathematics in motion. The hand is the tool of tools, speech is a tool. The history of tools and of their invention is the history of the growth of the human mind. We have no space for further samples of Dr. Carus's fine treatment of his subject, but we must give the following suggestive remark of his: "The development of tools . . . as for instance, at the present date, the construction of dynamos and motors, makes toward a certain ideal. When an invention is made, such as the bicycle or the typewriter, we find very soon a great variety of them in the market. By and by, however, they begin to approach one another in form, and in the end, when all the patents have expired, one looks very much like the other, even in the arrangement of apparently accidental details."

STANDARD TABLES FOR ELECTRIC WIREMEN. With Instructions for wiremen and linemen, underwriters' rules, and useful formulæ and data. By Charles M. Davis. New York: The W. J. Johnston Co. [Cloth. 32mo. 128 p. $1.]

THIS is the fourth edition of a popular work. Among the important additions that it contains may be mentioned the new insurance rules of the Underwriters International Electric Association, and a section on the calculation of alternating current wiring, which brings this subject within the reach of practical men. Some of the tables given were prepared expressly for this work and cannot be found elsewhere.

CHANCES OF SUCCESS: Episodes and Observations in the Life of a Busy Man. By Erastus Wiman. New York: American News Co. [Cloth. 16mo. 359 p. $1.]

IN these days, when every man is being enclosed in an entirely new set of circumstances, the vigorous lines of Erastus Wiman in the pictures he has drawn are very attractive. Thus an article entitled "The Basis of Things" sets in new colors the utter dependence of the whole body politic on the man who alone produces food and fiber—the farmer. Without foreign trade and its profits, without interest from loans or investments abroad, without gains from maritime commerce, there is no dependence except upon the farmer. Yet by the strong lines of Mr. Wiman's picture the farmer is found to be steadily declining in purchasing and debt-paying power, and revival is impossible until he and the vast class dependent upon him, comprising three-fourths of the population, are in better condition. Another picture of strong and vigorous treatment, side by side with this, relates to the question, "Has the national debt ever been paid—or is it only shifted?" Mr. Wiman makes clear that, if any one is bearing this weighty burden, it is the farmer on whose extrication all our hopes depend. The hope of the future is the revival of profit for the producer, and here again is another strong presentation in the treatment of the question of the "Future Food Supply," of the "Land's End," of "Fields a Thousand Miles Square," and literally a gallery of kindred subjects. Hung in with these vigorous touches there is a variety of episodes in legislatures, adventures in hunting excursions, and an infinite assortment of interesting and amusing matter. There are over 200 distinctive subjects treated, and the index shows over a thousand topics touched. As an economic treatise it is unique in its interest; as a book of stories it is unique in its strong and crude treatment of economic topics now in every man's thoughts, and universally discussed by high and low, rich and poor.

THE RELATION OF ECONOMIC CONDITIONS TO THE Causes of Crime. By Carroll D. Wright. Philadelphia: American Academy of Political and Social Science. [Paper. 8vo. 116 p.]

COLONEL WRIGHT starts out with the proposition that the causes of crime, in a sociological sense, cannot be studied without considering the statuts of man in the prevailing industrial order, for economic conditions contribute to the existence of crime. Crime was not so fully recognized under the slave and feudal systems as under the modern free-labor system. While the modern system is far superior to those that preceded it, it must be considered as having a direct relation to the causes of crime in so far as it superinduces idleness or unemployment. The lines of crime rise and fall as the prosperity of the country falls and rises. The intelligent and skilled laborer is rarely found either in a penal or a charitable institution; and statistics show that no desirable working material can be found among convicts. Industrial depression makes tramps and criminals, while ignorance and the lack of technical training force men into the ranks of criminals. Too much cannot be done to avoid the misery of trade stoppages. Again, sanitary conditions are necessary to material prosperity; the health of the workers depends directly on the conditions of sewerage, light, ventilation, and housing. Ignorant labor implies ignorant employers. Undue subjection of labor is undesirable from the employer's own standpoint. The efficiency of labor depends on the standard of living to a great extent. Trade instruction, technical education, manual training, justice to labor, and equitable distribution of profits are efficient elements in the reduction of crime and pauperism.

SECOND REPORT OF THE BUREAU OF MINES OF ONTARIO. For the year 1892. Archibald Blue, Director. Toronto: 1893. [Paper. 8vo. 264 p.]

THIS report is a marked improvement upon the former one. It is more complete in its statistics and more systematic in its arrangement. The principal topics treated are: Statistics, iron-ores, iron-mining and pig-iron making, nickel and cobalt ores and metallurgy, new sources of platinum, utilization of peat, the mining laws of Ontario, etc., to which is appended the report of the inspector of mines. The summary of the mineral production for 1892 shows a total spot value of $5,374,000, and that in making this output wages to the amount of $2,591,344 were paid. In reaching the totals, however, a number of items are included which should be rather classed as manufactures than as crude mineral products, as, for example, brick, tile, cement, illuminating oil, lubricating oil, paraffin wax, etc. Among the leading products are: Gypsum, 3270 tons; salt, 43,337 tons; nickel, 2082 tons; petroleum, 28,000,000 gallons, and natural gas to the value of $160,000. The total value exceeds the production of 1891 by $668,466.

MASSES AND CLASSES. A STUDY OF INDUSTRIAL CONDITIONS in England. By Henry Tuckley. Cincinnati: Cranston & Curts.

THE aim of the author is to sketch the industrial situation in England as it actually is, dwelling particularly upon wages and the relation of the wage scale to the cost of living. Representative classes of workmen are dealt with, such as the 'bus- and train-men, clerks, railway-men, working girls, school-teachers, agricultural laborers, mechanics, and post office employés. To avoid dryness, figures are illustrated by personal facts. The author finds that the facts preclude altogether any rational comparison of British with American workmen, either as regards their present condition or their prospects. According to English sociological investigators, at the present time, of the working classes, one in two, if he reaches the age of sixty, is almost certain to come upon the poor law for his subsistence. Under these circumstances it is not to be wondered at that the labor question is in the forefront of English politics, or that the workmen are better organized there than in America, where opportunities and rewards are so much superior. Mr. Tuckley tells a melancholy tale, but he adheres closely to the truth. His little book contains useful information on the subject of "how the other half lives."

HOME RULE FOR OUR AMERICAN CITIES. BY ELLIS P. Oberholtzer. Philadelphia: American Academy of Political and Social Science. [Paper. 8vo. 95 p. 25 cents.]

REFERRING to the failure of municipal government in the United States, Mr. Oberholtzer, after pointing out that it does not add much to the discussion to aver that the electors themselves are alone to blame if they permit dishonest and inefficient men to administer their municipal affairs, expresses the opinion that one of the primal elements in the difficulty is found in the relation between the States and the city governments. Cities are, with few exceptions, the creations of the States. The charters are liable to change at the pleasure of the granting power, and the interferences are frequent and contrary to the needs of the city. Mr. Oberholtzer notes with approval the tendency to place restrictions on the legislatures in the matter of granting and amending city charters, and advocates a complete divorce of State and city. He would have our large cities stand in the same relation to the national government that the States do; he would make them "free cities," independent of the State legislatures. "The interests of all our large cities," he says, "are totally diverse from the interests of the remaining sections of the States in which they are placed by our artificial arrangement of boundaries," and he would have them make their own charters and constitute self-controlling, self-reliant governments. The subject is important, and new ideas should be carefully entertained by all who realize the need of reform in this sphere.

NOTES ON THE TESTING AND USE OF HYDRAULIC CEMENT. By Fred P. Spalding, Assistant Professor of Civil Engineering, Cornell University. Ithaca, N. Y.: Andrus & Church.

THIS little book is designed for use as a text in a short course of instruction as well as to serve the purpose of a handbook in the laboratory. The author gives a brief statement of the general properties and characteristics of hydraulic cement and its behavior under the more common contingencies of use. The various tests which may be applied are also discussed, and the precautions necessary in making tests of quality are pointed out. A chapter is added comprising a select list of recent periodical literature relating to the subject.

NEW BOOKS OF THE MONTH.

Ball, Sir Robert Stowell.=In the High Heavens: A Series of Sketches of Certain Parts of Astronomy. Illustrated. Philadelphia: J. B. Lippincott Co. [Cloth. 12mo. $2.50.]

Benton, G. Willard.=A Laboratory Guide for a Twenty Weeks' Course in General Chemistry. Boston: D. C. Heath & Co. [Cloth. 12mo. 163 p. 40 cents.]

Brooks, W. K.=The Genus Selpa: A Monograph: With a Supplementary Paper, by Maynard M. Metcalf. Limited edition. Two volumes. Baltimore, Md.: The Johns Hopkins Press. [4to. 396 p. 57 colored plates. $7.50.]

Bishop, H. H.=Pictorial Architecture of France. E. & J. B. Young & Co. [Coth. 8vo. 175 p. $3.]

Carhart, Daniel.=A Field-Book for Civil Engineers. Boston: Ginn & Co. [Cloth. 9–281 p. $2.50.]

Carus, Paul.=The Philosophy of the Tool. A lecture delivered before the Department of Manual and Art Education of the World's Congress Auxiliary. Chicago: The Open Court Publishing Co. [Paper. 12mo. 26 p. 10 cents.]

Commons, J. R.=The Distribution of Wealth. New York: Macmillan & Co. [Cloth. 12mo. 258 p. $1.75, net.]

Cox, W. Edward.=The Compass: A Journal for Engineers, Surveyors, Architects, Draughtsmen, and Students. Vol. II. New York: Keuffel & Esser Co. [Cloth. 8vo. 192 p. $1.75.]

Haney, J. D., *compiler.*=The Expert Calculator: A Complete Compendium of Short Cuts in Figures and Useful Business Information. New York: Excelsior Publishing House. [Cloth. 16mo. 149 p. 25 cents.]

Hart, Albert Bushnell.=Practical Essays on American Government. New York: Longmans, Green & Co. [Cloth. 12mo. $1.50.]

Hobhouse, L. T.=The Labor Movement. With preface by R. D. Haldane. New York: G. P. Putnam's Sons. [Cloth. 12mo. $1.25.]

Huxley, T. H.=Darwiniana: Essays (Vol. II of collected essays). New York: Appleton. [Cloth. 12mo. 6–475 p. $1.25.]

Kennelly, A. E.=Theoretical Elements of Electro-Dynamic Machinery. Vol. I. Illustrated. New York: D. Van Nostrand Co. [Cloth. 8vo. 2–89 p. $1.50.]

King, J. H.=Man an Organic Community: being an exposition of the law that the human personality in all its phases in evolution is the multiple of many sub-personalities. Two volumes. New York: G. P. Putnam's Sons. [Cloth. 8vo. $4.50.]

Letis, E. A.=Qualitative Analysis Tables and the Reactions of Certain Organic Substances. New York: Macmillan & Co. [Cloth. 4to. 91 p. $3, net.]

Loftie, W. J.=Inigo Jones and Wren; or, the Rise and Decline of Modern Architecture in England. New York: Macmillan & Co. [Cloth. 8vo. 284 p. $4.50.]

Lotz, Walter.=Monetary Situation in Germany. Philadelphia: American Academy of Political and Social Science [Paper. 8vo. 20 p. 25 cents.]

Luquiens, Jules, *editor.*=Popular Science. Edited and annotated by Jules Luquiens. Boston: Ginn & Co. [Cloth. 12mo. 4–252 p. (International Modern Language Series. French prose.) 60 cents.]

Morris, W., and Bax, E. Belfort.=Socialism, Its Growth and Outcome. New York: Imported by C. Scribner's Sons. [Cloth. 12mo. 6–335 p. $1.]

Newman, J.=Notes on Cylinder Bridge Piers and the Well System of Foundations, Especially Written to Assist Those Engaged in the Construction of Bridges, Quays, Docks, River Walls, Weirs, Etc. New York: Spon & Chamberlain. [Cloth. 8vo. 136 p. $2.50.]

Nicholson, J. Shield.=A Treatise on Money and Essays on Monetary Problems. Second edition. Vol. I. New York: Macmillan & Co. [Cloth. 12mo. 415 p. $2.50.]

Smith, Goldwin.=Essays on Questions of the Day: Political and Social. New York: Macmillan & Co. [Cloth 12mo. 6–360 p. $2.25.]

Sayward, W. H.=Thoughts on the Relations of Employer and Workman: a lecture delivered in Boston, Mass, 1893. New York: Funk & Wagnalls Co. [Cloth. 8vo. 15 p.]

Spelling, T. C.=A Treatise on Trusts and Monopolies: Containing an exposition of the rule of public policy against contracts and combinations in restraint of trade, and a review of cases, ancient and modern. Boston: Little, Brown & Co. [Cloth. 8vo. 27-274 p. $3.50, net.]

Spencer, Adam.=Roll-turning for Sections in Steel and Iron: Being an appendix to the author's larger work. New York: Spon & Chamberlain. [Cloth. 4to. 21 folding plates. $4.25.]

Suess, E.=The Future of Silver: Translated by Robert Stein. Published by permission of the author and by direction of the Committee of Finance, Senate of the United States. Washington, D. C.: Government Printing Office. [Cloth. 8vo. 2-101 p.]

Turner, J. H. T., and Brightmore, A. W.=The Principles of Waterworks Engineering. Illustrated. New York: Spon & Chamberlain. [Cloth. 8vo. 429 p. $10.]

Woollcombe, W. G.=Practical Work in Heat: For Use in Schools and Colleges. New York: Macmillan & Co. [Cloth. 12mo. 61 p. $1, net.]

Van Brunt, H.=Greek Lines and Other Architectural Essays. Boston: Houghton, Mifflin & Co. [$1.50.]

Watson, K. W.=Treatise on the Kinetic Theory of Gases. New York: Macmillan & Co. [Cloth. 12mo. 87 p. $1.]

Wells, Sidney, H.=Engineering, Drawing, and Design: A Practical Manual for Engineering Students. Illustrated. Two volumes. Philadelphia: J. B. Lippincott Co. [Cloth. 12mo. $2.50.]

Woodford, Arthur Burnham.=On the Use of Silver as Money in the United States. An historical study. Philadelphia: American Academy of Political and Social Sciences. [Paper. 8vo. 60 p. 25 cents.]

Young, Francis Chilton, *editor*.=Decorative Work for House and Home. Illustrated with numerous explanatory sketches and diagrams. New York: Ward, Lock, & Bowden, Limited. [Cloth. 6-94 p. 40 cents.]

Ziwett, Alexander.=An Elementary Treatise on Theoretical Mechanics. Part 2.—Introduction to Dynamics; statics. New York: Macmillan & Co. [Cloth. 8vo. 183 p. $2.25.]

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THE WORLD'S FAIR BUILDINGS THROUGH FRENCH SPECTACLES.

By Jacques Hermant.

THE portico constituting the entrance to the Chicago Exposition recalls in its proportions that superb Corinthian ordonnance which so majestically precedes the grand basilica of the capital of the Christian world; the two pavilions which terminate it are indisputably and by far the best studied works among those that seek their inspiration in ancient art and that of the Renaissance. But why are the balustrades which crown the whole surmounted by a profusion of statues whose outline is as complicated as uninviting and which seem ready to lose their balance in the winds of a seldom placid lake?

And especially why this little triumphal arch which the monumental proportions of the portico render still more insignificant, when one would have fancied rather the Marine Gate of the Exposition covered by some gigantic arcade worthy of that America which hesitates at nothing?

Indeed, would it not have been much better to frankly interrupt the portico, thus giving a free view of the infinite horizon of the lake which everywhere it seems to have been the aim to hide, as if Chicago were ashamed of this sea which is not a sea? After all, perhaps it was the intention that nothing should distract the visitors' attention from the spectacle prepared for them. Perhaps there was some fear of that peculiar attraction which the sight of immensity so exercises upon our eyes that we fix them obstinately upon it and cannot take them off. And then, however vast the work of man, would it not have seemed somewhat petty beside that of nature?

But, say what we may of its situation, the peristyle preceding the Exposition on the lake shore is none the less one of the best works, if not the best, that we shall find there. It does great honor to its author, Mr. C. B. Atwood of Chicago, to whom we award this eulogy with the more pleasure from the fact that we must elsewhere find him guilty of a plagiarism hardly pardonable in a man of talent.

To the right of the entrance the Manufactures building stretches almost to the limit of vision the mass of its immense nave, as broad as the Machinery Hall at Paris, of which it is but a somewhat unhappy imitation, and more than sixty feet higher, surrounded by aisles whose exterior façade offers a monotonous succession of very simple arcades broken at the axes and the corners by pavilions which are literal reproductions of the triumphal arches of old Rome.

Here not the slightest effort at imagination or at composition, not a new idea ; the entire building is a copy, from the decoration of the tympana of the arches to the socles of the pillars of the balustrade.

We will not dwell upon the interior, which, of all the World's Fair buildings, is certainly that which is arranged with the least regard for the exhibitors, or upon that unlucky gallery, situated hardly twenty feet above the ground floor, which casts its unfortunate shadow over all the aisles and compels the use of the electric light at noonday. This building has been condemned by all those who have been invited to locate in it, and we believe that it proves for the second time and definitively that the system of colossal naves is absolutely unfavorable to the exhibition of products, especially those of the industrial arts. Their use should be reserved for railway stations, where they are much more in place.

Mr. George B. Post of New York aimed to amplify and adorn the Paris Machinery Hall, but he produced only a Palais de l'Industrie almost as great a failure as its ancestor in the Champs-Élysées.

Back of the Manufactures building—that is, after crossing the right arm of the canal—lie the Electricity and Mining buildings, each treated in a mongrel style of architecture, inspired by the Roman Baths and the Italian Renaissance.

In the Electricity building Messrs. Van Brunt and Howe of Kansas City have specially applied themselves to the achievement of an outline full of motion ; they have tried to render their architecture as light as possible, as well within as without. The gables which terminate the roof of the central nave in the form of a Greek cross are flanked by two square pylons supporting windowed campaniles, which give the whole an aspect of an Italian church of the seventeenth century. At the corners similar pylons surmounted by similar campaniles occur again to cut the outline and disconcert the eye, which has hardly been prepared by the very calm and restful lines of the lower ordonnance for such an abundance of pinnacles and spires.

In opposition to his neighbors, who are to be credited with a certain lightness of hand, Mr. S. S. Beman of Chicago, to whom fell the task of housing Mines and Metallurgy, suffered himself to be carried a trifle far in that expression of power which, it is true, befits his subject. In his architecture one plainly feels the heavy hand of iron which extends over modern German art and covers with a veil of sadness and oppression the works of the most brilliant artists.

At the left of the entrance, and corresponding to the three edifices of which we have just spoken, are located the Agriculture and Machinery buildings. Two more great palaces, the first of which is symmetrical with the Manufactures building, while the second covers a surface equal to the combined areas of the Electricity and Mining buildings and the passage between them.

The Agricultural building, the work of Messrs. McKim, Meade & White of New York, offers in its wealth a very curious contrast with its vis-à-vis. Whereas the Manufactures building is characterized by monotony and the straight line, in the Agricultural building movements, flights, and complication seem to have been particularly sought.

As a point of departure, again Rome, always the Baths.

At the center a portal surmounted by an attic and a pediment, back of which rises a dome in the shape of a depressed calotte; at the corners large massive pavilions connected by a series of nine arcades interrupted at intervals of three by pylons profiling even in the cornice. Over all these flights, which in themselves cut, agitate, and even slash the façade, a profusion of groups: bellowing cattle, prancing horses held in hand by winged figures, eagles, women scattering flowers and crowns in space, all actively standing out against the sky, at disturbing heights, in a manner more disorderly than decorative.

Here, however, it is not the architects alone that are to blame. At most they can be accused, knowing as they do the inexperience of American sculptors, of having left to these so fine a share.

Over the landings, bridges, and stairways are scattered groups of animals and figures of astonishing *naiveté* and pretension. The animal sculptors especially seem to have taken as their decorative ideal the stuffed specimens in anthropological museums, and it is a painful surprise to meet at every turn these bears, tigers, elks, or buffaloes as thin as though they had been wandering for months in the Pampas.

It would be an injustice nevertheless not to give flattering mention to Mr. Macmonnies, whose monumental fountain—perhaps a little too closely related to that of Coutan in the Champ-de-Mars —contains bits that are superb.

At the left of this vast composition we find Machinery Hall, which is certainly one of the most interesting buildings of the World's Fair.

Messrs. Peabody & Stearns of Boston have given much study to the Spanish Renaissance ; perhaps, in the decoration of their corner cupolas, they have even remembered too vividly its complex riches and its love of detail. But we can only praise without reserve their grand entrances, standing out against broad bare surfaces that rest the eye and lead it without effort to the two windowed campaniles whose sharp spires point delicately skyward and support light figures which, without contortion, spread their wings and seem ready to fly away into infinity.

The general ordonnance of the façade consists of a simple Corinthian corridor surrounding the whole building, whose ground-floor pierced by vigorous arcades offers a proper contrast to the delicacies of the upper story. All shows the artistic sense ; fine in its detail, it is not on too large a scale, and it certainly would gain by not being in the vicinity of the enormities that surround it.

We have not yet spoken of the Dome, that isolated cupola in the broad esplanade which extends back of the central sheet of water, from the monumental fountain to the principal railway station. Here we must sincerely confess our embarrassment.

We have no longer to deal with an unknown, we are confronted with the work of a master, of a man who has contributed more than any other to the development of architecture in America during the last half-century and who is known not only by his works but by his love for France, where he studied. We should like to speak of Mr. Richard M. Hunt of New York with the same frankness that we have shown in the preceding pages, and we fear that our respect and the affection that many of us bear him do not leave us quite at liberty.

This capital work which by its height dominates the whole of Jackson Park bears lofty testimony to the science and skill of its creator. Here there is no awkwardness to shock, no faults of detail to betray the architect's inexperience. All is poised, in perfect equilibrium. Each part is learnedly studied ; the curve of the dome is felicitous, and its brilliant decoration offers at certain points analogies (though distant) with the Dôme des Invalides ; it would be difficult, indeed, to formulate a precise criticism. Why, then, is the eye not satisfied ?

In our view it is because the point of departure is bad. To make of the Administration building a dome superior in its proportions to those of the Pantheon simply because it was expected that fêtes were to be given there (though, in fact, they were never given) was to force the departmental offices back into the annexes, which therefore had to be extended in order to afford sufficient room. Hence the four corner pavilions which were intended to support the central portion of the structure, but which really so crush it that its axial entrances seem to be at the extremity of a cul-de-sac. Moreover, the basements are thereby given such importance and vertical development that the lofty colonnade surrounding the dome does not properly subordinate them.

Must we blame the artist who was thus asked to solve an impossible problem ? We think not, and we are even of the opinion that there are few among the cleverest who would have met the difficulty more successfully.

The only criticism which it seems to us possible to pass upon him relates to the upper part of the cupola. Why not have terminated it by a campanile, a pinnacle, a top of some sort, to arrest the line and emphasize the summit ? One cannot help feeling a strange sensation of incompleteness, which all the reasoning in the world fails to explain.

If this is an attempt to depart from precedent, Mr. Hunt must excuse us for telling him frankly that it is not a happy one.

It would tire the reader were we to pass in review one after another the innumerable minor structures that rise in every direction,—State buildings, pavilions of foreign nations and of certain large manufacturers, Austrian, German, Irish, Turkish, Dahomeyan, and other villages, covering the immense area of the park, in which a crowd of 700,000 people can circulate with ease. Therefore we will simply point out in passing the beautiful glass cupola of the horticultural exhibition, whose author, Mr. V. L. B. Jenney, has improved his opportunity in an excellent fashion, though his work is somewhat marred by the bad proportions of the entrance pavilions and the deplorable execution of a frieze in bas-relief, as high as the arcades which it crowns.

We must not fail, however, to recognize the Art Gallery which all the pupils of the École des Beaux-Arts have seen pass before their eyes in the collection of Grands Prix de Rome, and whose literal copy, due to Mr. C. B. Atwood, is perhaps a flattering tribute to French superiority in architecture, but does little honor to the imagination of the artist who could compose the peristyle of which we have already spoken.

And now we come to the two works which are indisputably the most original of all and which attract the most attention from those who seek new manifestations.

We refer to the Transportation and the Fisheries buildings.

The Transportation building, the work of Messrs. Adler & Sullivan, abruptly breaks the monotony of whites and throws into the ensemble a note of violent color which in itself alone would suffice to draw the attention of all.

Let us say at once that they lose nothing thereby, and that the ingenuity of the decoration merits the attention which we give it at first in spite of ourselves. Imagine a long bare wall pierced by arches without molding, crowned by a high projecting square flagging ornamented on its face by one of those ingenious friezes of foliage which are, so to speak, the personal mark of Sullivan. The entire façade is painted in a very vigorous red, serving as a background against which stand out ornaments in which yellows and greens prevail, of manifestly Oriental inspiration, but frankly modernized by two men of talent, Messrs. Healy and Millet, decorative painters, who are already famous in Chicago through numerous works of the greatest interest.

Above this ornamentation appear large winged figures, of a primitive manner, symbolizing in a very unexpected way the genii of Science.

At the middle of the building opens the Golden Doorway, conceived in the same spirit. It has faults, but, in spite of them, one cannot refuse to recognize it as a work of very great imagination in its detail, of a boldness of composition that is perhaps excessive and of an originality that fearlessly declares itself.

To take a tunnel entrance as the starting-point of the principal doorway of the Transportation building and to treat it so freely and roughly that the initial idea remains sufficiently manifest ; to devise for its decoration a series of ornaments brilliant enough to give it astonishing wealth without in the least detracting from the savagery of the lines ; to dare to face the whole with a metallic patina of gold and silver which gives it the appearance of a gigantic specimen of the goldsmith's art,—this is not commonplace.

It is not perhaps in the best taste ; it is neither very pure nor very logical ; but, amid the old arsenal of columns and pediments reconstructed by the authors of the works which we have just reviewed, it would be unjust not to devote special attention to this attempt of artists desirous of quitting the beaten paths.

Very interesting also from the same point of view, but distinguished by qualities of a different order, is the Fisheries building.

Mr. Henry Ives Cobb, of Chicago, is not as uncompromising an innovator as his two fellow-citizens ; he does not seek those violent contrasts of lines and colors of which they are fond ; he has none of those audacities which are hardly to be indulged except by a certain contempt for the arrangement of details.

Here we are in presence of a delicate and curious inquirer who wishes to impart his personal note to the most intimate portions of his composition, but whose first care is to shock nobody.

The Fisheries building is composed of a central structure in which are exhibited the technical parts of the exposition, the products and appurtenances of fishing. This structure is connected by a slightly curved corridor with two circular pavilions in which are placed superb aquariums containing fish of the most various and varied species. A crowd continually presses before this marvelous exhibition of animals of the strangest forms that move about gracefully amid the marine plants so dear to them in large glass tanks affording them perfect liberty of motion.

But, after having admired them at length, it is not without a certain astonishment that this crowd halts at the exit before the façade of the building and there again discovers, sporting in the capitals, winding along the columns, and entwining to form balusters, all this marine fauna and flora which it has just viewed in actual life.

The façade in itself has the requisite unity and simplicity. A sort of cloister formed of an infinity of little arcades borne on small columns envelops it with its firm and delicate lines and is repeated above the roof to again surround all the upper portion. The appearance is like that of those beautiful convents of the days when Italy, stubbornly resisting Gothic art, had not yet found its way back to ancient Rome and was living under the influence of Lombardic and Byzantine memories.

But, however interesting in itself, the general architecture of the building is nothing beside the details for which it gives a pretext. The capitals and columns have received each a different decoration, composed of marine plants, fishing appurtenances, fish whose odd forms have served to supply most unexpected *motifs*, each happier than the other, of an originality that charms and a variety that surprises.

One little expected to find here such an outburst of skill and such knowledge of arrangement coupled with a taste so sure.

Mr. Ives Cobb is an artist who is master of himself, and we salute him the more willingly because, to any one who has been willing to follow attentively this long chat upon architecture in the United States, it is unhappily certain that there are still in America more men who consider it as a profession than as an art.

But let us be careful ; here and there already are to be found some temperaments more solidly tempered than the rest, which offer victorious resistance to that sort of depression of the brain caused by the exclusive pursuit of money. Perhaps it is at the very moment when those who are so furious in the contest for its possession feel all their treasures escaping them in consequence of the depreciation of metal that is to begin in America, not the Renaissance, but the Naissance of an art which must be the direct resultant of all that Europe knows and all that those of her children desire who have gone across the Atlantic in search of the liberty which they lacked and the room which they no longer found.—*Gazette des Beaux-Arts.*

SHIPS OF THE NEW BRITISH NAVY.

By W. Laird Clowes.

THE new navy of Great Britain, so far as its ironclad battleships are concerned, may be said to date from the time of the construction of the first vessels of what is known as "the Admiral class." This class, comprehending six ships that bear the names of distinguished British admirals, was launched between 1882 and 1886, inclusive, and was designed under the superintendence of Sir Nathaniel Barnaby. Since then we have seen launched two battleships of the *Sans Pareil* class (1887), two of the *Trafalgar* class (1887-88), seven of the *Royal Sovereign* class (1891-92), one of the *Hood* class (1891), and two of the *Centurion* class (1892); and we have begun to build one of the *Renown* class and two of the *Majestic* class.

The new navy of Great Britain, so far as its cruisers are concerned, dates from about the same period, and includes the two first-class armored cruisers of the *Imperieuse* type (1883-84), the seven first class armored cruisers of the *Aurora* type (1886 87), the two first-class protected cruisers of the *Blake* type (1889 90), the four first-class protected cruisers of the *Royal Arthur* type (1891-92), the five first-class protected cruisers of the *Edgar* type (1890-92), the four second-class protected cruisers of the *Arethusa* type (1882-83), the four second-class protected cruisers of the *Mersey* type (1885-86), the eleven second-class protected cruisers of the *Andromache* type (1890-92), the ten second-class protected cruisers of the *Pique* type (1890-92), the eight second-class protected cruisers of the *Fox* type (1891-93), the two third-class protected cruisers of the *Medea* type (1888), the three third-class protected cruisers of the *Magicienne* type (1888), the four third-class protected cruisers of the *Barracouta* type (1889), the two third-class protected cruisers of the *Barham* type (1889-90), the nine third-class protected cruisers of the *Katoomba* type (1889 90), the seven third-class unprotected cruisers of the *Archer* type (1886-87), and the two third-class unprotected cruisers of the *Fearless* type (1885-88). In addition we have, still under construction, two first-class protected cruisers of the *Powerful* type and three second class protected cruisers of the *Minerva* type.

As for craft of miscellaneous character, I have to catalogue the torpedo-depôt ship *Vulcan* (1889), the ram *Polyphemus* (1881), three torpedo gunvessels of the *Grasshopper* type (1886-87), the torpedo-gunvessel *Rattlesnake* (1886), the eleven torpedo gunvessels of the *Sharpshooter* type (1888-90), the eleven torpedo gunvessels of the *Antelope* type (1891-93), the five torpedo gunvessels of the *Dryad* type (1893-94), the six "station" gunboats of the *Partridge* type (1888), the nine "station" gunboats of the *Goldfinch* type (1889), the eighteen first-class torpedo boats numbered from 79 to 97 inclusive (1886-94), and forty two torpedo boat-destroyers (most of which are still in early stages of construction) of the *Havock* and kindred types. To these may be added two "station" gunboats of the *Alert* type, which are being built.

The general details of the various types above mentioned are thrown into tabular form on a succeeding page in order to save space and facilitate reference.

A few other modern ships which I might include are omitted, as they possess few if any characteristics, save their armament, to distinguish them from vessels of older type.

THE NEW BRITISH NAVY—BATTLESHIP "ROYAL SOVEREIGN."

THE NEW BRITISH NAVY—BATTLESHIP "ROYAL SOVEREIGN."

PRINCIPAL DETAILS OF BRITISH WAR-SHIPS

Type.	Dimensions in Feet.			Displacement in Tons.	Indicated Horse Power.	Coal Capacity Tons.	Contract Speed Knots.	No. of Ships Composing the Type.
	Length.	Beam.	Mean Draft.					
A 1 "Admiral"..	325 330	68 68.5	25.8 27.8	9,500 10.600	9.500 11,500	900	16.5 16.7	6
A 2 Sans Pareil	340	70	26.8	10,470	14.000	750	16.7	2
A 3 Trafalgar ...	345	73	27.5	11,940	12.000	900	16.7	2
A 4 RoyalSovereign	380	75	27.5	14,150	13.000	900	17.5	7
A 5 Hood.	380	75	27.5	14,150	13.000	900	17.5	1
A 6 Centurion.. ...	360	70	25.5	10,500	13,000	750	18.2	2
A 7 Renown.	380	72	26.9	12,350	12,000	800	17.0	1
A 8 Majestic.... ...	390	75	27.5	14,900	13,000	900	17.6	2
B 1 Imperieuse ...	315	62	27.3	8,400	10.000	900	16.7	2
B 2 Aurora	300	56	22 8	5 600	8,500	900	18 5	7
C 1 Blake........ ..	375	65	25 9	9,000	20,000	1 500	22 0	2
C 2 Royal Arthur..	360	61	24.7	7,700	12,000	850	19.5	4
C 3 Edgar...	360	60	23.7	7,350	12,000	850	19.7	5
D 1 Arethusa... ...	300	46	19.0	4.300	5,000	1,000	17.0	4
D 2 Mersey.........	300	46	18.0	4,050	6,000	750	18.0	4
D 3 Andromache...	300	43	16.5	3,400	9,000	400	20 0	11
D 4 Pique....	300	43 7	17.5	3.600	9,000	400	19.7	10
D 5 Fox	320	49.5	19 0	4,360	9,000	400	19 5	8
E 1 Medea...	265	41	16.5	2,800	9,000	400	20.0	2
E 2 Magicienne .. .	265	42	17.5	2,950	9.000	400	19.0	3
E 3 Barracouta....	220	35	14.0	1,580	3.000	160	16.5	4
E 4 Barham	280	35	13.2	1.830	6.000	140	19 5	2
E 5 Katoomba. ..	265	41	15.5	2,575	7.500	300	18.2	9
E 6 Archer...	225	36	13.5	1,770	3,500	250	17 0	7
E 7 Fearless..	224.5	34	13.5	1,580	3,200	250	16.7	2
C 5 Powerful.....	500	70	27.0	14,000	25,000	3,000	22 0	2
D 6 Minerva.......	350.2	53	20.3	5.500	9,600	550	19·5	3
F Vulcan..... .. .	350	58	23.0	6.620	12,000	1,000	20 0	1
G Polyphemus....	240	40	20.0	2,640	5,500	200	17·0	1
H 1 Grasshopper.. .	200	23	8.0	525	2.700	100	19·0	3
H 2 Rattlesnake....	200	23	8.0	550	2.700	100	18 5	1
H 3 Sharpshooter ..	230	27	8 2	735	3,500	100	19 2	11
H 4 Antelope.... ..	230	27	8.8	810	3.500	100	19 0	11
H 5 Dryad....	250	30 5	9.0	1,070	3 500	100	19·0	5
K 1 Partridge..... ..	165	29	11.3	755	1,200	105	13 2	6
K 2 Goldfinch......	165	31	11.6	805	1.200	105	13 7	9
M Torpedo-boats .	135 to 150	14to17 5	5.5to6	105 to130	1,100to2,000	20 to 35	20 to 24	18
N Havock..... ...	180	18.5	5.0	215	3,300	60	26.5	42
K 3 Alert.	180	32 6	11.6	960	1,400	130	13.2	2

Of the classes noted in the table, A^6, A^7, B^1, C^2, D^4, D^5, E^2, C^5, D^6, and K^3 are wood-sheathed and coppered; K^1 and K^2 have steel frames planked with wood; and all the remainder have steel hulls. All the classes except K^2 and M have twin screws; but there is as yet no example in the British navy of a ship with triple screws.

The eight battleship types (A^1 to A^8) are of very great interest. They represent the history, during a period of fifteen years or thereabouts, of the efforts of English naval architects, and especially of Dr. W. H. White, C. B., the admiralty director of naval construction, and his assistants, to secure the best possible compromise and to reconcile in the wisest way the rival claims of heavy guns and heavy armor, size and speed, radius of action, and

THE NEW BRITISH NAVY—"CAMPERDOWN," OF THE "ADMIRAL" CLASS.

THE NEW BRITISH NAVY—FIRST-CLASS ARMORED CRUISER "AURORA."

displacement, elevation of main battery and stability at sea, protection and habitableness in peace-time, and a hundred other pairs of conflicting factors ; and I venture to think that most of the decisions which appear to have been arrived at and embodied in the designs are thoroughly defensible. It has been recognized, on the one hand, that no thickness of armor capable of being carried on the sides of a ship of practicable dimensions will keep out all the projectiles that can be hurled against it, and, on the other hand, that so long as a given gun will at moderate range easily pierce any armor now afloat, it is, comparatively speaking, wasteful to employ a heavier gun. Both armor-thickness and gun-weights, therefore, have been reduced, while the total area of armored surface and the total number of medium-calibered guns have been increased. In the eight successive types of battleship classes the calibers of the heaviest guns have been, in chronological order, 16.2 in., 16.2 in., 13.5 in., 13.5 in., 13 5 in., 10 in., 10 in., and 12 in.

In the "Admiral" class the armored belt, though 18 inches in thickness, extended along only a little more than 45 per cent. of the ship's length. In the *Trafalgar* type the armored belt, 20 inches thick in some places, but only 14 in others, was extended along more than 66 per cent. of the ship's length. In the *Royal Sovereign*

THE NEW BRITISH NAVY—BATTLESHIP "SANS PAREIL."

THE NEW BRITISH NAVY—FIRST-CLASS PROTECTED CRUISER "ROYAL ARTHUR."

type the general thickness was reduced to 14 inches, and the proportion of length protected was still kept at nearly 66 per cent. of the whole, while some of the weights thus saved were utilized in the formation of armored casements around the broadside guns on the battery deck. The policy has been further developed in the *Centurion*, *Renown*, and *Majestic* types. The height of the muzzles of the heavy guns above the waterline has also been materially increased, to the great improvement of their fighting qualities when the ships are steaming against a head sea. The freeboard, forward and aft, of the ships of the "Admiral" class was only 10 ft. 3 in., and of those of the *Trafalgar* class but 11 ft. 3 in.; but the freeboard of the ships of the *Royal Sovereign* class is 18 feet, and their heavy guns are carried 23 feet above the normal waterline, while those of the *Trafalgar* type have a "command" of no more than 15 feet. This policy also is being maintained, if not further developed. In the meantime, if coal carrying capacity has remained nearly stationary, speed has improved a little, and gun-power has improved much. In the table at the head of the following page is given an instructive comparative statement of the guns and gun-power of the *Camperdown* (one of the "Admirals") and of the *Majestic :*

H. M. S. "CAMPERDOWN."

No.	Guns.	Total Weight of Guns Tons.	Total Muzzle Energy of Guns. Ft. tons.	Muzzle Velocity per Gun Ft secs.	Perforation of wrought iron at 1000 yds. per Gun. Inches.
4	13.5-in. R. B. L........	268	140,920	2,016	28 2
6	6-in. R. B. L........ ...	30	15,990	1 960	10 5
12	6-pr. 2 24-in. R. F......	4.8	1,650	1,810	2 5
7	3-pr. 1.85-in. R. F.......	1.7	562	1,873	1.8
29		304.5	159,122		

H. M. S. "MAJESTIC."

No.	Guns.	Total Weight of Guns Tons.	Total Muzzle Energy of Guns. Ft. tons.	Muzzle Velocity per Gun Ft secs.	Perforation of wrought iron at 1000 yds. per Gun. Inches.
4	12-in. R. B. L...........	*200	*100,000	*2,100	*23.0
12	6-in. R. F...............	76	40,272	2,200	14.0
16	12-pr. 3-in. R. F.........	8	6,304	2,133	6 3
12	3-pr. 1.85-in. R. F.......	3	963	1,873	1.8
44		287	147,539		

* Approximate.

Thus, while a saving of about 5.5 per cent. has been effected in the weight of guns carried, the number of guns carried has been increased by about 51 per cent., and the total muzzle-energy developed has been diminished (even assuming the moderate esti-

THE NEW BRITISH NAVY—SECOND-CLASS PROTECTED CRUISER "INDEFATIGABLE."

THE NEW BRITISH NAVY—STATION GUNBOAT "PIGMY."

mate for the new 12-inch guns not to be exceeded) by little more than 7 per cent. There can be no question, especially when one reflects how much greater a weight of metal the *Majestic* can discharge in a given time, that she is a far more offensively powerful ship than the *Camperdown*.

But, powerful, spacious, fast, and magnificent though the new British battleships undoubtedly are, it unfortunately must be admitted that they possess some by no means trifling faults, and first among these is the fault of being very indifferent gun-platforms. I have more than once seen ships of the *Royal Sovereign* type at sea with a fleet, and I have invariably remarked that they roll more freely than any other vessels in company. Excessive rolling is a defect which may, and in this case does, coexist with perfect safety so far as stability is concerned; but in a battleship it is none the less a defect. We have, ere this, fought fleet actions as well as single-ship actions in a heavy sea with a gale of wind blowing. The weather was all that was abominable when Sir Edward Hawke defeated M. de Conflans in 1759, and a situation of the same kind may easily occur in the next naval war. The *Royal Sovereign*, the *Empress of India*, the *Ramillies*, and the *Resolution*—all ships of type A^4—roll between 30 and 40 degrees each way on very mod-

THE NEW BRITISH NAVY—BATTLESHIP "NILE."

THE NEW BRITISH NAVY—TORPEDO-DEPOT SHIP "VULCAN."

erate provocation, and, when doing so, cannot possibly use their broadside guns at all, as the muzzle of the weapons would dip at each roll and the battery would be flooded through the ports. Nor can they, with much effect, use their heavy barbette guns; for such violent motion must render good shooting impossible, even if the guns themselves be well out of reach of the water. The defect would be diminished by the addition of bilge keels to the ships; but, owing to the great size of the vessels, it is found that such additions would render them incapable of entering any of our dry-docks, except No. 3 at Plymouth; and, as all the craft of this type are unsheathed and uncoppered, frequent docking is, unfortunately, necessary to their continued usefulness. Another defect which most of the new battleships share with most of the new cruisers is that they would possess hardly any bow and stern fire if some accident occurred to prevent the working of the heavy guns of the principal armament. This point has, I venture to think, been much more wisely considered by those who are responsible for the designs of the American coast-line battleships *Oregon*, *Massachusetts*, and *Indiana*, and of all the French battleships of recent types

In the matter of weakness of bow and stern fire the battleships of the *Royal Sovereign* type are, however, by no means the most unsatisfactory of modern British battleships. The *Sans Pareil* type, which included the *Victoria*, lost last summer in the Mediterranean, is worse. This type carries two monstrously heavy guns (16.25 inches, 111 tons) in a turret on the low forward deck, but cannot bring to bear on a point ahead of the ship any other weapon bigger than a 6-pounder. The heavy guns that can be trained right astern are confined to one 10-inch and two 6-inch. This feebleness will best be realized if I compare the bow and stern fire of the type with the bow and stern fire of the United States ships of the *Oregon* type, which are of less displacement:

	H. M. S. "SANS PAREIL." Guns.	Total Muzzle Energy. Ft. tons.	U. S. S. "OREGON." Guns.	Total Muzzle Energy. Ft. tons.
Bow.	2 .. 16.25 in. 111 ton	108,780	2. .. 12 in.	51,970
			4.... 8 in	29,992
			2... 6 in.	5,980
	2	108,780	8	87,942
Stern.	1... 10 in. 29 ton	14,430	2 .. 12 in.	51,970
	2.... 6 in. 5 ton	5,330	4.... 8 in.	29,992
			2 ... 6 in.	5,980
	3	19,760	8	87,942

The bow fire of the *Sans Pareil*, though certainly heavier than

THE NEW BRITISH NAVY—TORPEDO-GUNVESSEL "GOSSAMER."

THE NEW BRITISH NAVY—TORPEDO-BOAT OF THE "M" TYPE.

that of the *Oregon*, is delivered by only one-fourth of the number of the *Oregon's* bow guns ; and I do not hesitate to say that if the *Sans Pareil* and *Oregon* had to fight one another bows on, and if the gunners of both ships were equally smart, the British ship—unless, of course, she happened to plant a lucky shot at the commencement of the action—would, say in a quarter of an hour, be unable to get rid of more than about half the energy that would be got rid of by the *Oregon*. As for stern fire, the *Oregon's* would be altogether superior from start to finish ; and, upon the whole, I would be inclined to think that against the *Oregon* the *Sans Pareil* would have but a poor chance.

As befits a power that has naval interests more widely scattered than those of any other nation, Great Britain ought to have given to her modern battleships a relatively large coal carrying capacity. Some of her earlier ironclads have stowage for as much as 1200 tons or even more, but none of the modern ones have provision for upwards of 900 tons; and I think that this is, if gaged by other standards, an insufficient amount. I give, by way of illustration, some statistics of the quantity of coal carried, per horse-power developed at full speed, by the most modern battleships of the leading countries. The figures following the names represent hundred-weights :

GREAT BRITAIN.		UNITED STATES.		FRANCE.		ITALY.	
Benbow,	1.5	*Maine*,	1.8	*Neptune*,	1.4	*Morosini*,	1.7
Sans Pareil,	1.0	*Oregon*,	.8	*C. Martel*,	1.2	*Sicilia*,	1.2
Royal Sovereign,	1.3			*Masséna*,	1.0	*Sardegna*,	1.0
Renown,	1.3	RUSSIA.		AUSTRIA.		*Am. St. Bon*,	.8
Majestic,	1.3	*Tchesme*,	1.5	*Kr. Pr. Rudolf*,	1.6		
		Tri Sviatitelia,	1.5				
		Alexander II.,	3.0				

Now if the United States finds it necessary to give as much as 1.8 cwt. of coal per horse-power; if Italy finds it necessary to give 1.7 cwt., and if Russia finds it necessary to give 3 cwt. to a ship,—surely we in England, looking to the extensive nature of the British empire, and the probability that action may be required in comparatively distant waters, ought to give our battleships more than 1.3, or even more than 1.5 cwt., per horse power. The relative smallness of our bunkers may, I fear, handicap us seriously, should we in the near future be plunged into war.

The armored-cruiser classes (B^1 and B^2) of the new British navy have proved very satisfactory in one important respect. They are all excellent steamers, and, in everyday practice, they attain perhaps a greater proportion of their nominal speeds than any other modern vessels of war afloat. But in two other respects they are disappointing. For two reasons they scarcely deserve

THE NEW BRITISH NAVY—RAM "POLYPHEMUS."

THE NEW BRITISH NAVY—FIRST-CLASS PROTECTED CRUISER "BLENHEIM."

the name of armored cruisers. Firstly they have very short belts, and secondly such belts as they have are almost entirely submerged when the vessels have all their coal and stores on board in readiness for sea. In a word, if in war-time one of these vessels left a British home port on a cruise and a few hours after leaving were met by an enemy, for all practical purposes she would not be an armored cruiser at all, but merely a protected one, owing to the fact that all, or nearly all, her external armor would be under water. Some error was, apparently, made in the original calculation of, and provision for, the weights to be carried.

The numerous types of unarmored cruisers, protected chiefly by means of horizontal armored-decks, have, upon the whole, been fairly successful as steamers; but as fighting ships most of them, and especially those of the later varieties, leave much to be desired. Particularly deserving of condemnation in this respect are the numerous vessels of the *Andromache*, *Pique*, and *Fox* (D^8, D^4, D_5) classes. The guns of these, excluding machine-guns, are:

"ANDROMACHE" AND "PIQUE."	"FOX."
2 6 in.	2 6 in.
6 4.7 in.	8 4.7 in.
8 2.24 in. (6-pr.)	8 2.24 in. (6-pr.)
1 1.85 in. (3-pr.)	1 1.85 in. (3-pr.)

From their speed and certain other qualities, as well as from their official designations, it is clear that they are primarily intended (1) to act as scouts for a fleet, and to show their heels to heavy-armored vessels, and (2) to catch and take lightly-armed vessels. In pursuance, that is, of one part of their duties, they are expected to flee and fight stern on, and in that of the other part to chase and fight bows on. Never, as far as arrangement of armament is concerned, were ships worse fitted for either kind of service. Each of these 29 vessels has a single 6 inch gun on the deck forward, and can only bring that and a couple of 6-pounders to bear on any craft of which she may be in chase. She has also a single 6-inch gun on the deck aft, and can only bring that and a couple of 6-pounders to bear on any craft which may be chasing her. For bow- or stern-fire, in fact, all her 4.7-inch guns and half her 6-pounders are perfectly useless. The total bow- (or stern-) fire of these vessels amounts merely, in weight of metal, to 112 pounds, and, in aggregate muzzle energy, to 3636 foot-tons. To show how utterly inadequate this is, I append a statement of the amount of bow fire from guns of 5-inch caliber and upwards, of these and of cruisers in the navies of other countries, of about equal displacement—viz., between 3400 and 4360 tons :

Cruiser.	No. of guns bearing ahead.	Weight of metal thrown. Lbs.	Muzzle energy developed. Ft. tons.
United States, *Charleston*	3	450	12,478
Germany, *Irene*	4	305	10,275
France, *Jean Bart*	3	266	7,113
Great Britain, *Andromache*, etc.	1	100	3,356

In the British classes which are here described the practice of placing the forward guns on each broadside in sponsons has, for some mysterious reason, been abandoned. Hence comes the remarkable deficiency of bow-fire. But in the larger cruisers of the *Royal Arthur* and *Edgar* classes the old practice has been retained, and those ships, in consequence, have available for right-ahead fire 3 guns, throwing 580 pounds of metal, and developing in the aggregate a muzzle energy of 17,622 foot-tons. Attention is being paid to further improvement of bow-fire in the *Powerful* class (C^5), but the improvement will not go as far as it should. Cruisers of that enormous size, with their 70 feet of beam and their high freeboard, ought to be able to bring to bear right ahead at least 1 9.2-inch, 4 6-inch, and smaller guns. The actual arrangement of the armament is, as I write, still undecided ; but it is determined that, in addition to machine-guns, it shall consist of :

No.	Guns	Weight of Metal. Lbs.	Muzzle energy. Ft. tons.
2	9.2-in. R. B. L.	760	21,820
12	6- in. R. F.	1,200	40,272
18	3- in. R. F.	216	7,092
12	1.85-in. R. F.	36	963
44		2,212	70,147

This is an armament of a very serious character. If the ship were engaged on both sides simultaneously, and if the guns were loaded, trained, elevated, and fired as smartly as similar guns are worked every day by the men of H. M. S. *Excellent* at Portsmouth, the number of aimed shots delivered in a space of one minute by the above guns might be about 300 and the weight of metal about 3¾ tons. I do not cite this as an example of what could be done during any considerable number of minutes, but merely to show the nature of the fire which the *Powerful* will be capable of delivering for a more or less brief period. The ship will also carry Maxim automatic machine-guns. She is to have tubulous boilers of the (French) Belleville pattern, but these are being made in

England. The 6-inch guns probably will be in separate armored casemates, as in the battleships of the *Royal Sovereign* type.

The torpedo depôt ship *Vulcan* began her existence as a failure, and, having had her boilers altered, is continuing it as an experiment. Her original design embodied a number of remarkable errors. There were ports for the hoisting out of mines, which were actually below the water-line when the vessel was loaded for sea; there were hydraulic- or steam-pipes arranged in such close proximity to the hatchways for the hoisting up of torpedoes from the magazines that their rupture, with probably fatal results to the men engaged, would have been inevitable if the hatchways, in their primitive condition, had been used; and the great cranes which are a distinctive feature of the ship were at first so fitted that they were useless for hoisting out some of the second-class torpedo-boats which the *Vulcan* carries. But things have been and are being improved, and if Great Britain should in the future build yet another torpedo depôt-ship she ought, in the light of the experience now gained, to be a nearly perfect type.

The *Polyphemus*, the only craft in the British navy that has been specially built to serve primarily as a ram, has met with much professional approval, but the growing distrust of the practical value of the ram in naval warfare seems to have prevented this type from being either repeated or developed in England.

Of the torpedo gunvessel, or torpedo-boat catcher types (H^1, H^2, H^3, H^4, and H^5), little that is favorable can be said. The *Rattlesnake* is the best of the series. Most of the others cannot preserve a decent speed in a seaway; and I have over and over again seen the torpedo-boats, which they were intended to catch, easily show them a clean pair of heels. Their future usefulness will probably be confined almost entirely to service as ordinary gunboats; and the duties for which they were designed will, it is hoped, be performed by the new class (N) of fast torpedo boat destroyers, of which the *Havock* serves as a type. She is really little more than an unusually large and unusually fast sea-going torpedo-boat. Several of her numerous sisters will at their trials do over 27 knots an hour, and, from my own experience on the *Havock*, I incline to think that these craft are better sea-boats than their appearance at first sight suggests.

The new British torpedo-boats are very satisfactory, save perhaps that they are not quite fast enough. I have been in them in all weather, and can speak extremely well of their sea-going qualities. Various French, Russian, German, and Italian boats are faster, but, with the possible exception of a few of the German, I doubt whether any are as good all round.

The slow gunboats (K^1, K^2, and K^3) scarcely deserve inclusion in a catalogue of modern ships of war. They are designed chiefly for what may be called police purposes and for operations against uncivilized peoples, but they are good little vessels of their kind. Of ships which have not yet been begun I forbear to speak in detail. I will only say of them that, with regard to battleships, the tendency continues to run in the direction of more belt-armor, while, with regard to cruisers, it points towards largely increased speed, and towards vastly improved bow- and stern-fire.

Our new navy is large in comparison with that of the United States. So is our still surviving old navy. But our naval activity, which I trust will not only be maintained but will also be increased, is stimulated by considerations very different from those which prompt the United States to endeavor to be strong upon the sea. The United States has to support the dignity of the flag and to defend the integrity of its coasts. England has to do this, but to do much more as well. First we have to preserve communication with outlying parts of the empire all over the world; next we have to secure the free oversea passage of our food supplies; and, finally, we have to be ready to meet European complications, which can scarcely cause America any serious uneasiness. While, therefore, we regard with brotherly satisfaction the development of that American navy of the good quality of which we have had in the now remote past such strong evidences, we trust that the people of the United States will bear in mind that nowadays our naval position is no menace to theirs, but that, on the contrary, it is likely to help theirs. Old quarrels—which were, after all, only family ones—having been long since disposed of, and, I hope, forgotten, we may both still remember that we are of the same blood; that for a long period we had a common history; and that forever there must be between us a nearer and more sympathetic tie than can unite any other two nations.

HOW THE ANCIENTS MOVED HEAVY MASSES.

By W. F. Durfee, M. Am. Soc. M. E.

SECOND PAPER.

IN the preceding paper attention was given to the means adopted by ancient peoples for transporting large masses of material. We now come to the methods employed by them for raising and placing in position building stones and monolithic monuments whose size and position have excited the wonder of mankind since the beginning of history.

The value of the inclined plane as a means of raising heavy masses to considerable heights was early recognized by mankind. The most ignorant savage could not fail to observe that it was much easier to attain the summit of a precipice by means of its inclined flanks than to scale its perpendicular face, and that by inclined and gradually-ascending natural paths he could reach heights which would have been utterly inaccessible by other means. Therefore the inclined plane—the simplest of the elementary mechanisms—was undoubtedly the earliest mechanical expedient used by man for raising large masses. As a preliminary to the building of the Great Pyramid, the engineers of Kufu (Cheops, 3050 B. C.) constructed an inclined plane of masonry for raising the stones from the level of the river to that of the rock platform on which the pyramids are built,—a height, according to the French survey, of 164 feet above the mean level of low water in the Nile. This inclined plane or causeway was over 3000 feet in length and had a width of sixty feet. Its eastern end was contiguous to a canal communicating with the Nile, by which the boats carrying the stones from the quarries could deliver them in readiness to be dragged up this vast ramp—doubtless the first artificial construction of the kind—on sleds, by men or animals, to their destination.

In speaking of the transportation of materials we have already incidentally mentioned the employment of the inclined plane when moving and simultaneously elevating large masses, and have shown that in comparatively recent years it was habitually used to facilitate the building of ships in America and Holland, and in the erection of buildings in China ; but inclined planes have also been

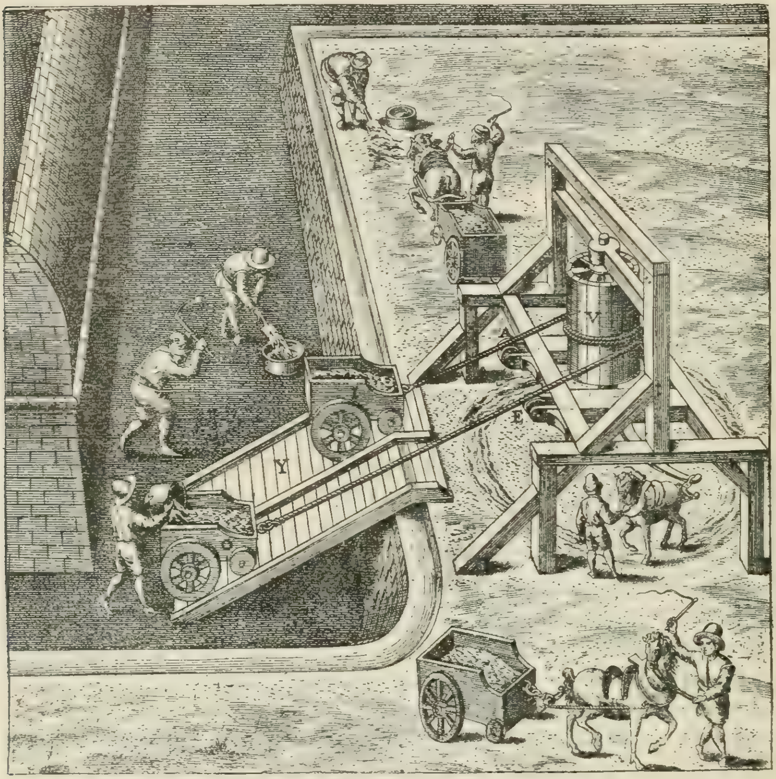


FIG. 1—INCLINED PLANE AND HORSE-WHIM COMBINED.

[From Le diverse et artificiose Machine del Capitano Agostino Ramelli. Parigi, 1588.]

used by many other nations in the erection of buildings. Colonel Wilkes states that, in the construction of the temples in India, "the immense stones were moved end foremost, up an inclined plane of solid earth, of as small an angle with the horizon as circumstances would admit, to the spot which they were to occupy in the wall. Long bamboo poles lashed to the stone at right-angles to its length, at such distance as merely to admit the efforts of rows of laborers between, constitute the chief means of propelling it by main force up the inclined plane, and its ascent is facilitated by means of rollers of small diameter, successively introduced under the stone, and prevented from sinking into the earth by rows of planks placed on each side of the stone, parallel with the line of ascent."

FIG. 2.

The figure on page 794 illustrates the application of the inclined plane in conjunction with the "horse-whim" for raising earth from the ditch of a fortification. Inclined planes have frequently been used in building operations in America. There is a well-authenticated tradition that all of the stones used in constructing one of the earliest cotton-mills in Massachusetts were dragged by oxen on "stone-boats" (the survival of the Egyptian sled) up

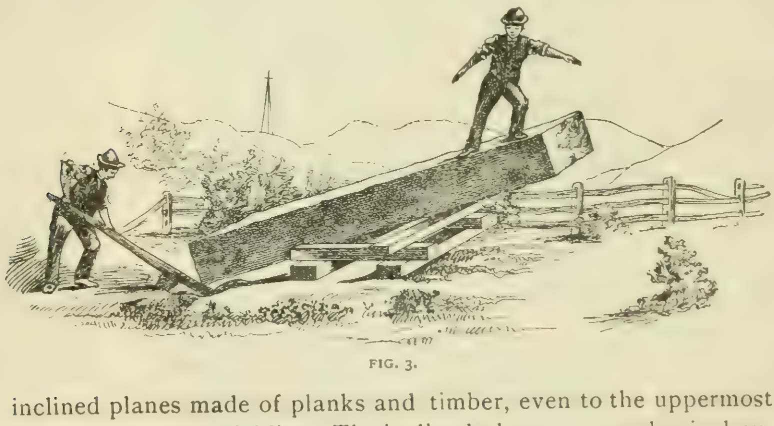


FIG. 3.

inclined planes made of planks and timber, even to the uppermost "stage" of the scaffolding. The inclined plane as a mechanical expedient for facilitating the raising of heavy masses is in daily use the world over in the form of "skids," and it is quite as impossible to number the years of its hoary antiquity as to fix with precision the exact date of the first concert of the morning stars.

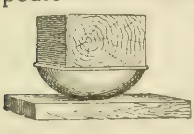


FIG. 4.

A method of raising and turning large stones in constant use in modern "quarries" and "stone-yards," which has been handed down to us from the remotest period, is illustrated by Figures 2, 3, and 4. In Figure 2 a massive stone is being raised by alternately

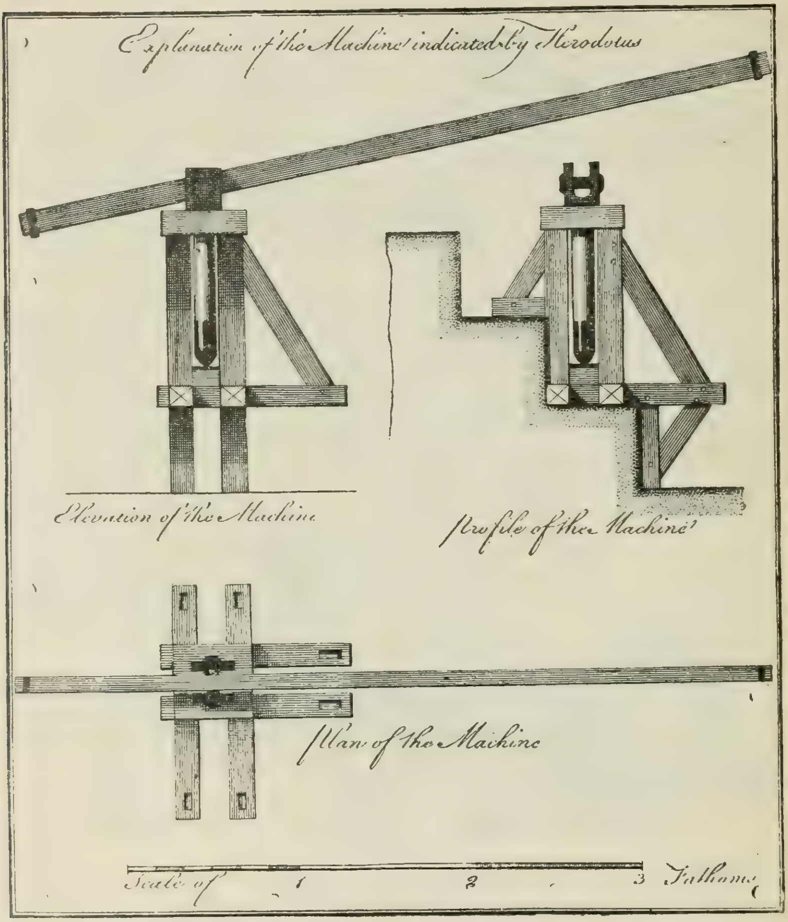


FIG. 5—DEVICE PROBABLY EMPLOYED ON THE GREAT PYRAMID.

tilting it and placing blocks of timber beneath on each side of its middle. This method, of course, is not suited to raising such stones through a great height, but for "getting them up" a few feet without moving them horizontally no method, in the absence of machinery, is simpler or easier, as the stone is made in a great degree to "lift itself" (to use a workman's phrase) and very little manual labor is required. Figure 3 represents a very old and still very common method of turning over a stone: a block of wood is placed so that when the stone is turned upon the block it will nearly balance, and very little effort will be required in "levelling

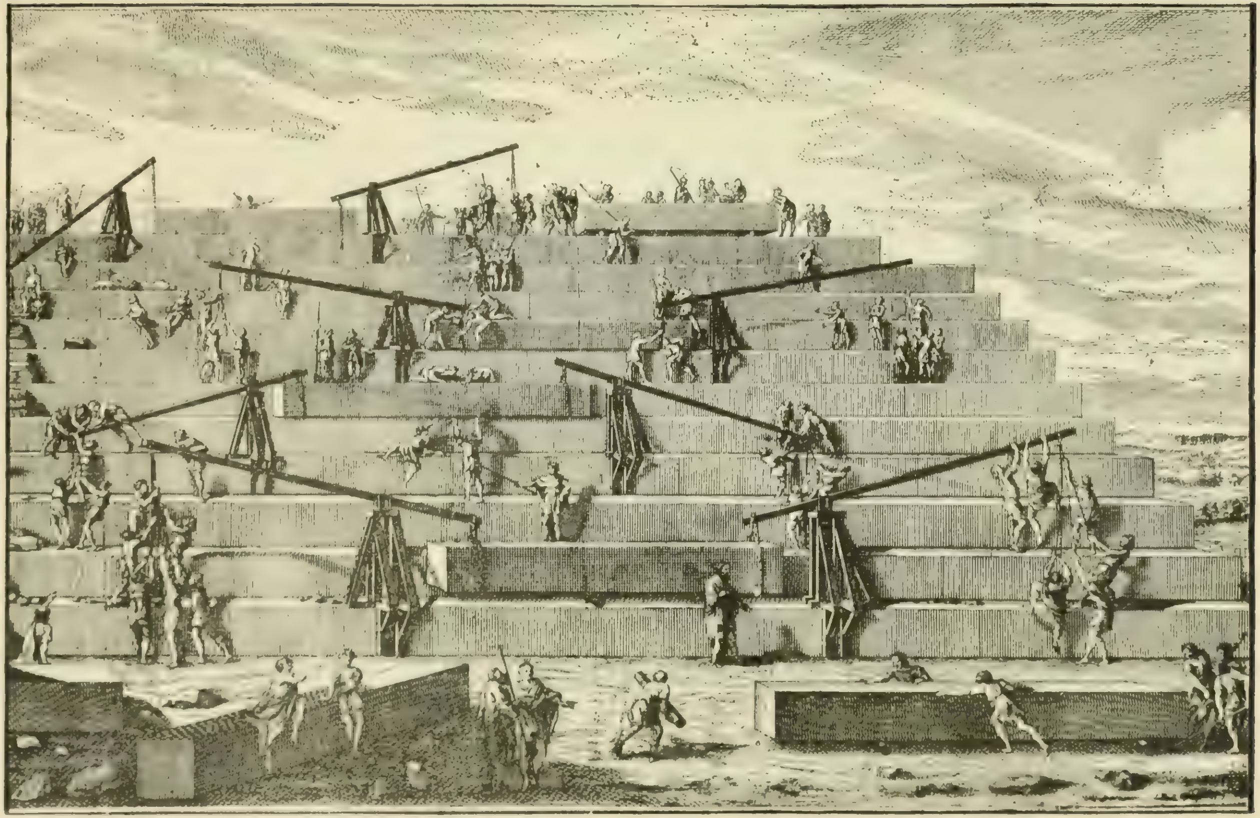


FIG. 6—APPLICATION OF THE DEVICE INDICATED BY HERODOTUS, ILLUSTRATED ON THE OPPOSITE PAGE.

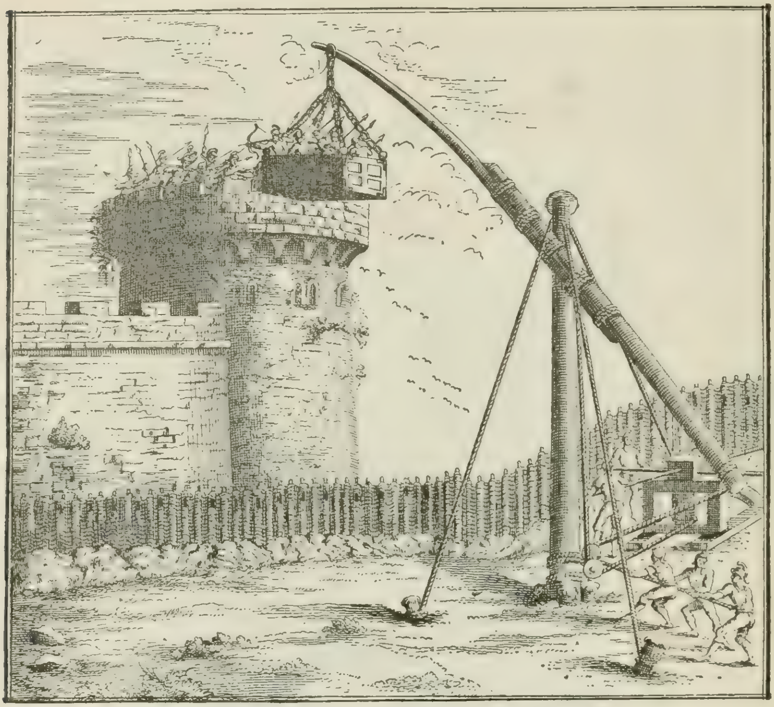


FIG. 7—USE OF THE CRANE IN ATTACKING A TOWER.

it up." In case it is desired to turn a stone "end for end," another ancient idea is employed: the stone is rolled upon a block of timber having a rough-hewn projection formed upon the middle of its lower side (as in Figure 4), which acts as a pivot on which the stone can readily be turned horizontally.

The means used by the builders of the Great Pyramid for placing its stones in position are not certainly known, but it is extremely probable that the methods illustrated by Figures 2, 3, and 4 were employed, for Herodotus states* that, "after laying the stones for the base, they raised the remaining stones to their places by means of machines formed of short wooden planks. The first machine raised them from the ground to the top of the first step. On this there was another machine which received the stone upon its arrival and conveyed it to the second step, whence a third machine advanced it still higher. Either they had as many machines as there were steps in the pyramid, or possibly they had

*Rawlinson's Herodotus, Vol. II, p. 203.

FIG. 9—METHOD DESCRIBED AS HAVING BEEN USED BY ARCHIMEDES AT THE SIEGE OF SYRACUSE FOR DESTROYING THE VESSELS OF MARCELLUS.

but a single machine, which, being bodily moved, was transferred from tier to tier as the stone rose; both accounts are given, and therefore I mention both."

The President de Goguet* makes a suggestion of a possible method of carrying into practice the description of Herodotus. Goguet's scheme is illustrated by Figures 5 and 6, which make it so plain that no detailed description is required. The lever, having a compound tilting and swinging motion, was doubtless already an old idea in Egypt, as it has been in practical use from the earliest times in every "shadüf" † (Figure 11) that creaks and swings on the banks of the Nile from its delta to Ethiopia. The shadüf was used for raising water by many other ancient nations; Layard found it figured in bas-reliefs in the ruins of Nineveh, and it has been in common use in Persia and other parts of Asia from the earliest times. In the shadüf is to be recognized the first attempt at the construction of the simplest of the numerous species of mechanism for raising and placing heavy materials, which we group under the generic term "crane"; and there is no improbability in the supposition that some modification of the shadüf similar to the machine suggested by Goguet was used for raising and placing most of the stones in the Great Pyramid.

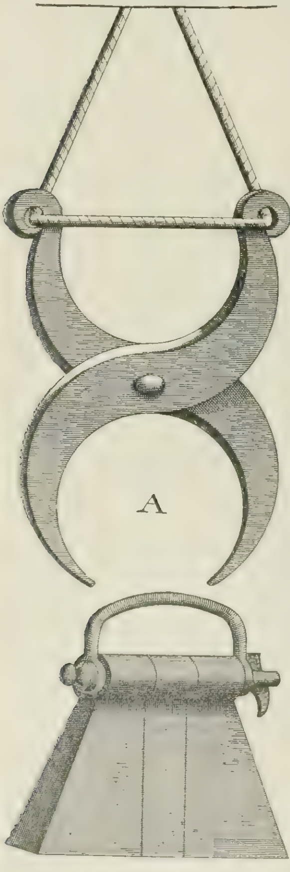


FIG. 9.

As for the largest stones, such as the fifty-six roofing-beams over the "king's chamber,"—which are each over twenty-six feet in length and more than fifty tons weight,—it is very probable that when they were required, an inclined plane of

* The Origin of Laws, Arts, and Sciences, and their Progress among the most Ancient Nations. Translated from the French of the President de Goguet. 3 volumes. Edinburgh, 1761.

† An interesting survival and translation of the idea of the ancient Egyptian shadüf is formed in the "well-sweep" once so common in rural New England, and which operated the "old oaken bucket" that "dripping with coolness arose from the well."

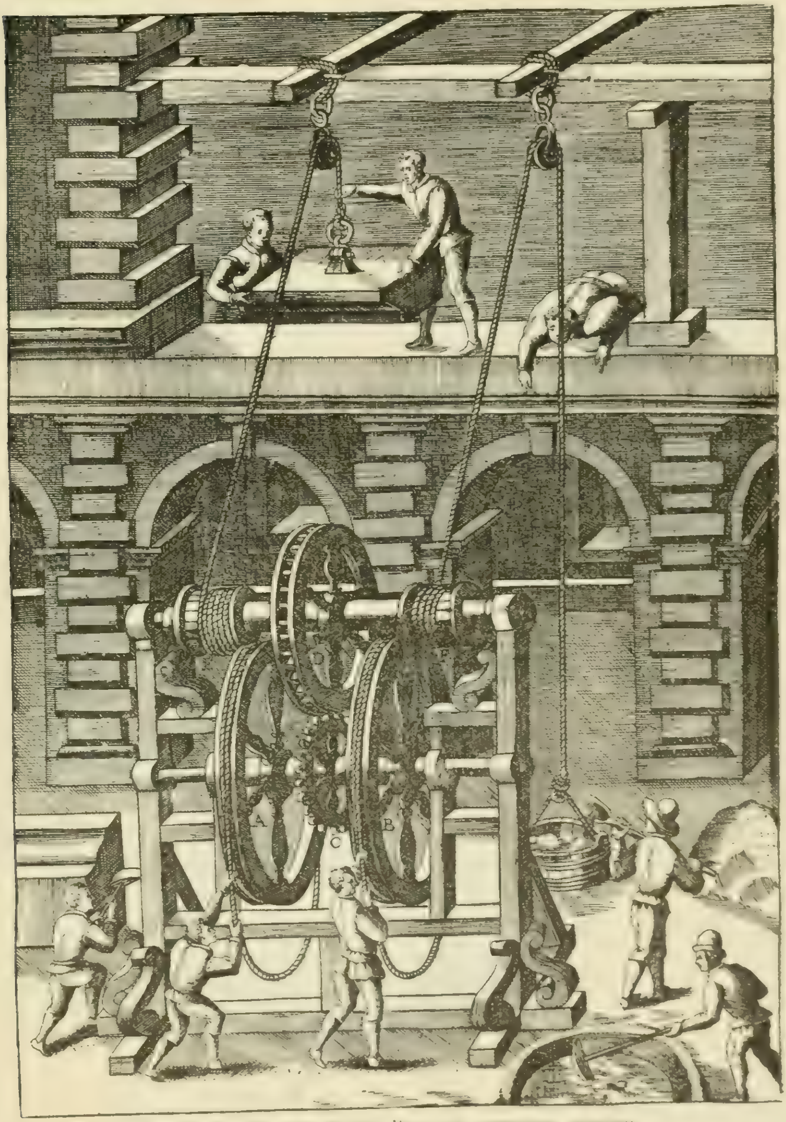


FIG. 10—USE OF THE "LEWIS" IN THE SIXTEENTH CENTURY.

timber was constructed up which they were dragged, for certainly the engineer who thought it necessary to construct the vast masonry inclined plane already referred to, for raising the stone from the boats to the level of the base of the pyramid, would have been likely to use a similar expedient for raising such heavy masses as these covering beams to their places in the building.

Cranes consisting of a suspended swinging lever were used in ancient military operations, both for attack, as shown in Figure 7, and for defense, as illustrated by Figure 8, which represents the method described as having been used by Archimedes to destroy the vessels of Marcellus at the siege of Syracuse (214–212 B. C.). Long levers suspended by a short chain from an elevated bracket arm were used in Italy as cranes for loading and discharging the cargoes of boats and other vessels as late as A. D. 1676. The means used by the ancients for securing chains and ropes to large masses of stone were various. Wherever possible the well-known method of "taking turns" of the rope or chain around the stone was employed. Quite frequently projecting "lugs" or "bosses" (which were chiseled off after the stone was placed) were left on the stone to prevent the ropes from slipping, or as points for their attachment. For the lighter stones the "tongs" (see *A*, Figure 9)* were used, and there is no doubt of the great antiquity of the "lewis"† (see *B*, Figure 9), while there is reason to believe that

FIG. 11—EGYPTIAN SHADUF.

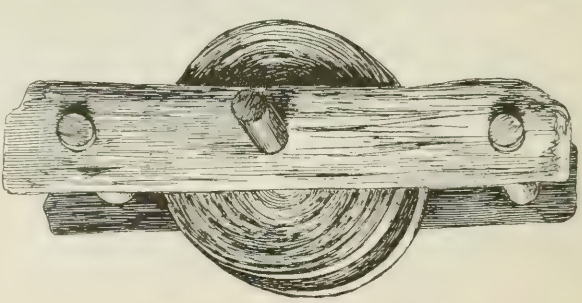


FIG. 12—ANCIENT EGYPTIAN PULLEY.

* From the English edition of The Architecture of Leon Battista Alberti, London, 1755. Alberti was born in Venice about the year 1404 and died at Rome in 1484. He was distinguished as a painter, poet, philosopher, musician, and architect.

† These tools are described by Vitruvius, who lived during the reign of Augustus, and they are not spoken of as recent inventions. In Knight's "American Mechanical Dictionary" the

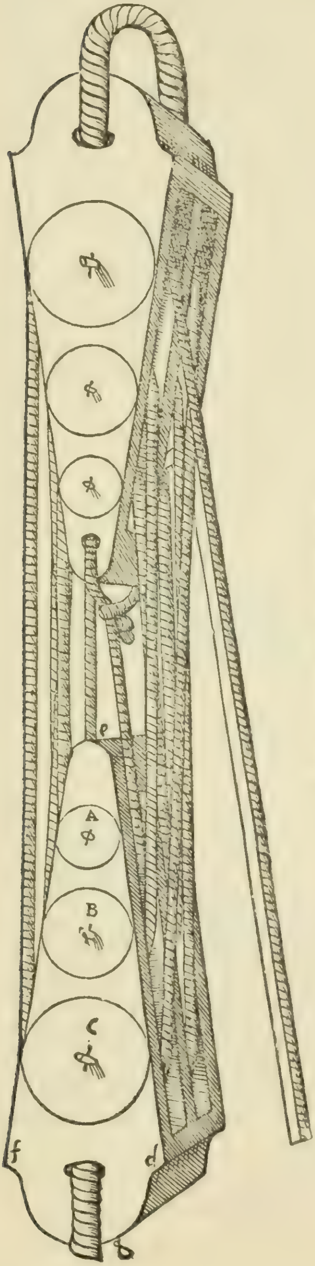


FIG. 13.—ANCIENT PULLEY-BLOCKS.
[From Vitruvius, about 50 B. C.]

it was known to the early Egyptians. Figure 10 illustrates the use of the lewis in the latter part of the sixteenth century. This engraving is also interesting from the evidence it affords of the early use of the rope-wheel in hoisting machinery. It will be noted that in this instance the rope goes one-and one-half times around the grooved wheel, instead of half round, as is now the usual practice.

"The ancient Egyptians," says Wilkinson," were not ignorant of the pulley, and one has actually been found [see Figure 12] and is now in the museum of Leyden ; it is however of uncertain date, and was apparently intended for drawing water from a well. The sides are of *athul* or tonarish wood, the roller of fir ; and the rope of *leef*, or fibers of the date-tree, which belonged to it was found at the same time." The pulley was well known to the Assyrians, and is represented on a bas-relief found at Nineveh by

"lewis" is claimed to have received its present form as the result of the improvements of "a Frenchman" who was architect to Louis XIV, and who gave the tool "the name it bears in compliment to his master." In view of the fact that the lewis as now made was used by the ancient Romans for lifting very heavy stones (Alberti states that he has "seen holes [for the lewis] over a foot deep"), it is very probable that this useful implement got its name from the Latin word *levis* (thou liftest), the second person singular of the verb *levo* (I lift). This is made the more probable from the letter *u* having often been written *v* in Latin. If we substitute *u* for *v* in "lewis," we shall have *leuis;* whence our present orthography *lewis*.

Layard. The ancient Greeks and Romans employed the pulley in various ways, and the construction of some of their "pulley-blocks" was quite different from any used at the present time. Figure 13 represents a pair of these "blocks" so plainly that no description is necessary. They also had "blocks" similar to those now in common use, and they were used in connection with sustaining frame-work quite similar to our "gins" and "derricks." Figure 14 illustrates an ancient form of "gin," in which the substitute for gearing is a "wheel and axle." It will be noted that the "blocks" are so "rove" that there are two "falls" to the rope, which are wound on opposite ends of the "axle," and that the "wheel" has a rope wound around it. Whenever it was desired to "hoist" anything to which the lower "block" was "hooked," animals or men were made to pull at this rope, and as it unwound from the "wheel" the two "falls" were wound on the "axle," and thus the weight was raised.

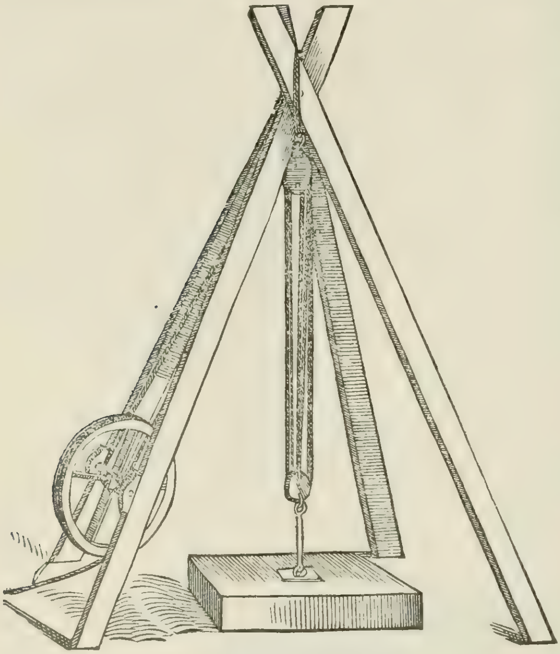


FIG. 14—ROMAN HOISTING GIN.
[From Vitruvius.]

Figure 15 represents a Roman mechanism identical in construction and use with our "capstan" and "shears."

Although the pulley was known and used by the most ancient peoples, still in many cases they preferred to employ means for raising great weights that had in them more of the elements of absolute safety than is found in pulleys and ropes. We are told by Dr. Kennedy, in his description of the construction of the Seringapatam obelisk, that "the elevation was at first accom-

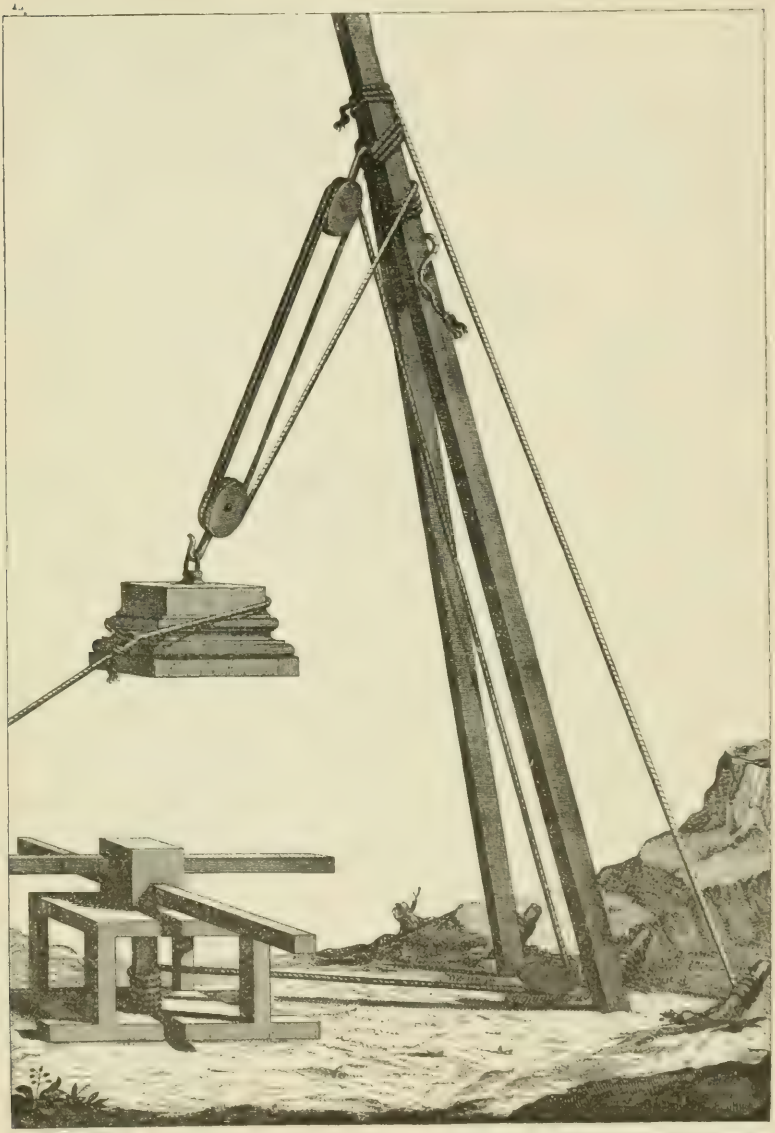


FIG. 15—ROMAN CAPSTAN AND SHEARS.

plished by men prying with handspikes over timbers arranged parallel with the obelisk, and as it rose earth was solidly rammed beneath it." This method certainly had the advantage of a max-

FIG. 16—SUPPOSED EARLY SUGGESTION FOR A CRANE.
[Reduced from Alberti.]

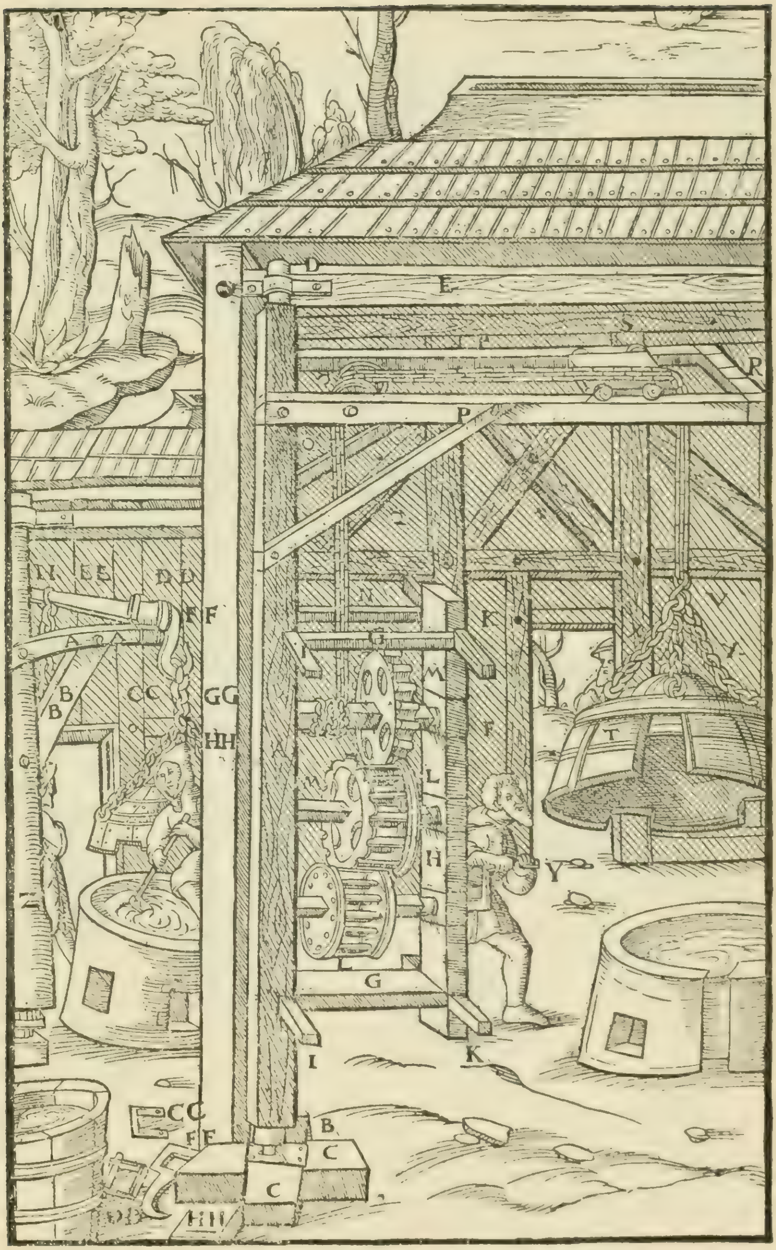


FIG. 17—ANCIENT CRANES FOR SMELTING-WORKS.
[Reduced from Georgii Agricola de re Metallic, Basileae, 1556.]

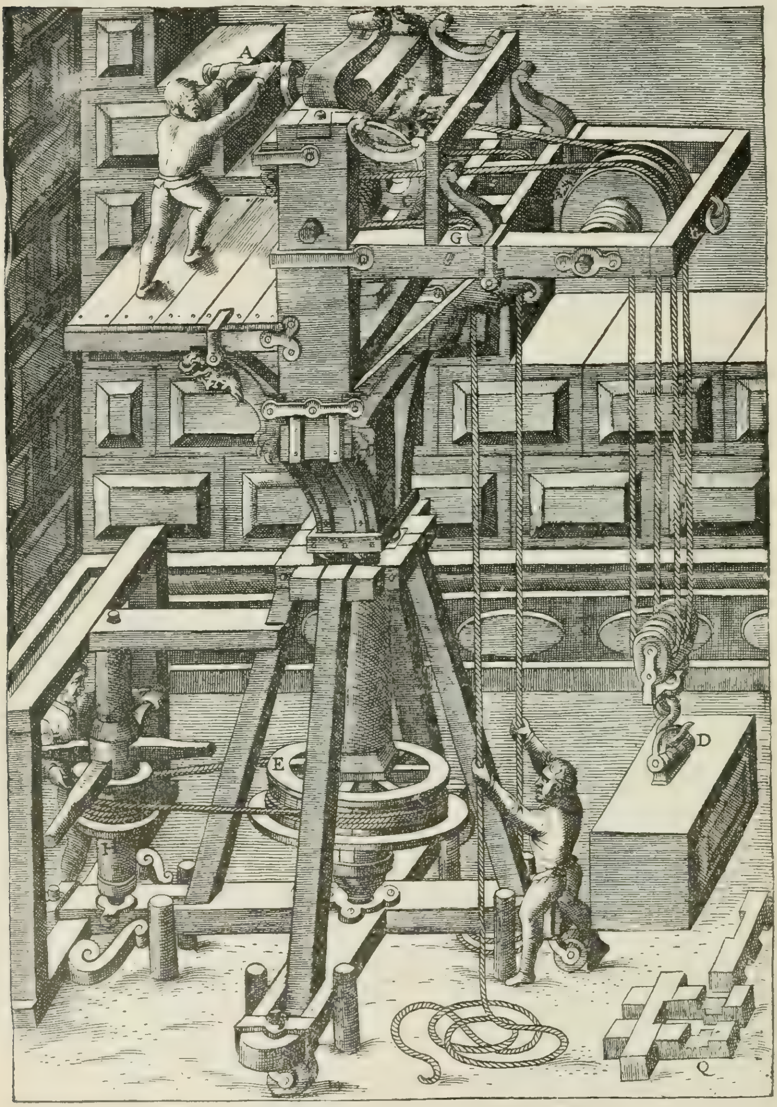


FIG. 18—ANCIENT PORTABLE CRANE FOR SETTING STONE.

imum degree of safety; and, as the operation was conducted exclusively by native workmen by their inherited ways, it is pretty safe to assume that by similar methods all such masses had been raised in India from the earliest times.

It is very probable that the Egyptian method of raising an obelisk was not as safe as the Hindoo plan, for Pliny states that "Rameses (1250 B. C.) made one [obelisk] ninety nine feet in height on which he employed 20,000 men; and, fearing that the engineer would not take sufficient care to proportion the power of the machinery to the weight he had to raise, he ordered his own son to be bound to the apex, more effectually to guarantee the safety of the monument."*

The first suggestion of a "crane" having a vertical post and horizontal arm was doubtless furnished by the trunk and projecting limb of a tree. The engraving, Figure 16, illustrates in a very spirited and fanciful manner this idea. Figure 17 exhibits two species of crane. The larger is pervaded by a suggestion of multiple gearing from "chain barrel" (or shaft) to the hand crank shaft, and there is also a manifestation of an intention of suggesting a traveling carriage or "trolley" on the arm of the crane, but there is no means evident for either moving or holding this trolley. The second type of crane, shown on the left of that just described, has especial interest, inasmuch as it is undoubtedly a survival of the old Egyptian shadüf, and the early suspended-lever cranes. In this case the operating lever is not pivoted for horizontal movement at its fulcrum, but this movement is effected by swinging the whole crane, the extremity of whose arm carries the fulcrum of the operating lever, which is actuated by a chain dependent from its long arm. For small movements and frequent lifts this very simple idea is well worthy of application at the present day. This engraving, like most illustrations of mechanism in old technical works, must be regarded rather as a rough sketch of the ideas than as a record of the actual proportions of practice.

In Figure 18 † we have a representation of a very peculiar and elaborate crane. It will be noted that the crane is made portable

* This story suggests the method proposed by *Punch* for preventing railway collisions: "Strap the managing director on the front of the locomotive."

† In this device [from Ramelli 1588] the hoisting is accomplished by turning the hand crank A, which operates the "worm" B, and its wheel C, on the axis of which is wound a pair of "falls," the free extremities of which pass over guide pulleys F. C, and are kept "taut" by a man on the ground. The other ends of the hoisting rope, after passing over the grooved wheel G, go under the pulleys in the "block" hooked to the "lewis" D, and then ascending are fastened to the axle of the wheel P, which is turned by the adhesion of the rope in its grooves. In hoisting, the rope is "taken up" in two ways: (1) by winding its free ends upon the axle of the worm wheel C, and (2) by winding its other end on the axle of the grooved wheel P. The turning of this crane is accomplished by means of the arms in the vertical shaft H, and its wrapping-rope connection with the wheel E.

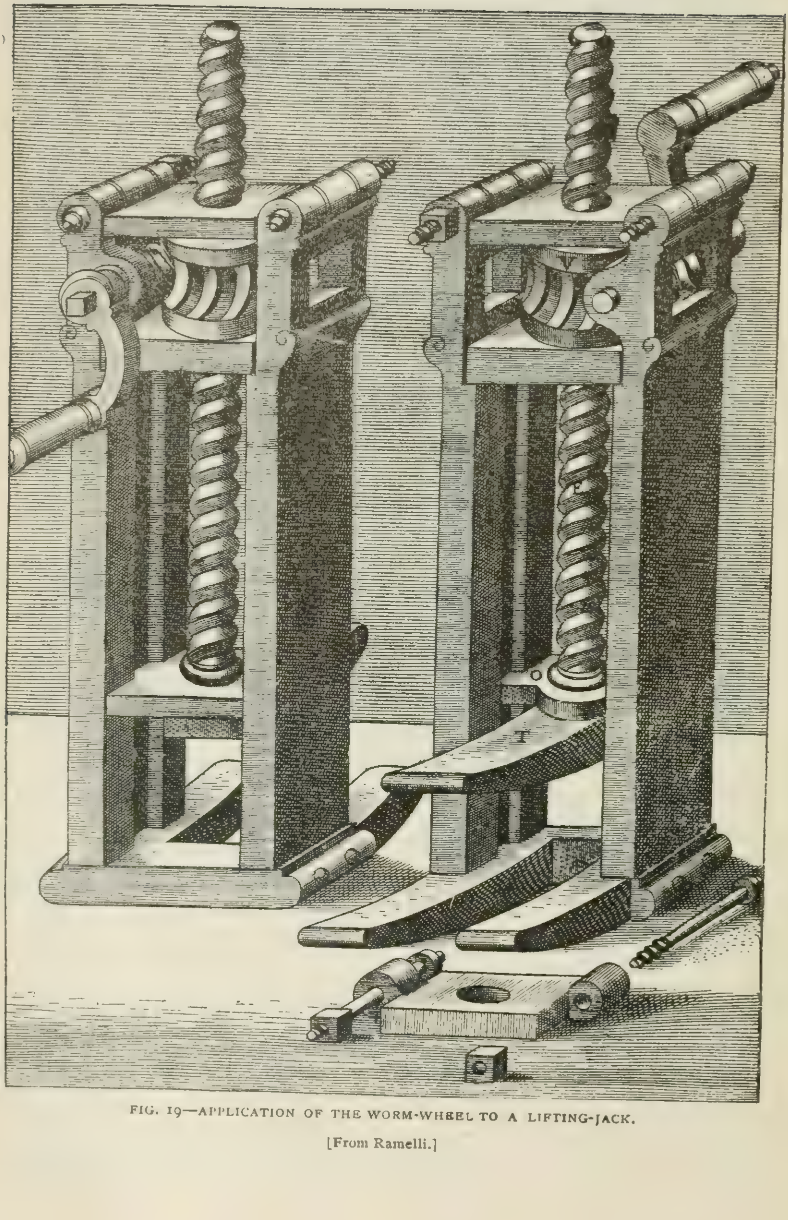


FIG. 19—APPLICATION OF THE WORM-WHEEL TO A LIFTING-JACK.

[From Ramelli.]

by being mounted on "casters" having broad-faced wheels. This engraving is especially interesting as illustrating the antiquity of the employment of the "worm-wheel" in the construction of cranes.

Figure 19 shows the application of the worm-wheel to a "lifting-jack," the wheel rotating about and forming the nut of the lifting-screw. Such "jacks" were designed for lifting the gates of fortified places off their hinges, and also for lifting or turning any heavy mass of material. This mechanical combination has been frequently employed, and has taken a variety of forms. Bessoni (1578) illustrates a press in which three screws, operated by as many worm-wheels, are used. The ordinary "jack-screw" was well known in the sixteenth century, as was also the "double-ended jack-screw," with right- and left-hand screws.

Much of curious interest might be added in continuation of this subject to more recent times, but the middle of the sixteenth century is probably quite modern enough for the expressed purposes of this paper, and therefore I will conclude my cross-examination of History with the usual words of dismissal to a witness: "That is all."

A PLEA FOR SERIES ELECTRIC TRACTION.

By Nelson W. Perry, E. M.

DURING the few years prior to 1879, when the hopes of utilizing the electric current for lighting purposes were high but not yet practically realized, electricians were perhaps about equally divided as regarded methods of distribution. The chief apostles of the two schools were Charles F. Brush and Thomas A. Edison. The former advocated the plan of distributing by unvarying current and the latter by unvarying potential. The former had met with considerable success with the arc lamp some time before the incandescent lamp became known to the public, and, so far as the operation of arc lamps was concerned, his success was as complete as was that of Edison later with the incandescent lamp. While Brush was working with large units intended to be distributed over large areas, Edison was working with smaller units intended for a more limited distribution, and each solved his own problem so satisfactorily that neither method has yet been supplanted in its own territory to any considerable extent by the other, although a borderland between the two territories has been occupied with varying degrees of success by both.

Brush employed a current of constant value and arranged his lamps in series with each other and the source of energy, so that the current passed through each in succession before returning to the generator, the increase of energy required by the multiplication of lamps being supplied by a corresponding increase in pressure at the generating station. This method had at least one recommendation: it admitted of a precise determination of the most economical size of conductors, which held the same relation towards economy so long as the cost of copper and steam-power remained the same, whether there were two lamps burning or fifty, or whether the line were one mile long or thirty. Another recommendation, scarcely less important in the light of subsequent events, was that it permitted the extension of circuits at all times on the lines already laid down without disadvantage to or modification of those portions already constructed. It labored at first under this great disadvantage, however, that since in his system every lamp formed an integral part of the circuit the failure of any disabled all, and the minor irregularities of operation were cumulative. The solution of this difficulty was found in the cut out or by-path provided in each lamp, through which the current was automatically shunted in case of failure of the carbons to feed. In this way the integrity of the circuit was maintained independently of the operation of the lamp, and the system has grown until now there is, theoretically, no limit to the number of lamps that can be placed on a circuit, each working independently of all the rest as though it were on an independent circuit. As a matter of fact the Brush company have recently constructed a machine intended to supply 125 2000-candle-power lights from one circuit, and there are many circuits in nightly use upwards of twenty miles in length. The series system, however, is not adapted to the distribution of small currents such as are employed in incandescent lamps. While it has not been approached in its adaptation to the arc lamp, it has made little progress, and that little it has lost, in the incandescent field.

Edison, on the other hand, followed the method of gas- and water- distribution common in our cities and elsewhere, wherein a constant head or pressure is maintained and the increased demand for energy is supplied by an increase in the flow under the unvarying head. By this method the capacity of the mains must be gaged by the sum of the individual demands; in planning an installation provision must be made for the future, and when that provision is exhausted additional mains must be laid to meet the increased demands. This method had the recommendation of greater flexibility, permitting the supply of all-sized individual demands from the same mains with practically independent circuits for each individual translating device. It had the disadvantage, however, of requiring much larger investments in copper, which increased under some circumstances as the square of the demand in current, and shared with our methods of gas-distribution the faults of loss of pressure as the distances increased, especially in cases where the drain upon the mains was large near the source of energy. For this reason the areas that could be supplied from centers of generation were exceedingly limited, though the method was sufficient for the early requirements. As the areas to be covered increased, the ingenious device was resorted to of dividing them up into smaller areas, whose centers were supplied by feeders and mains at the proper potential at their terminals for use throughout the local areas, and thus, and by means of the three-wire system which permitted the distribution of current at double the potential at which it was to be used, the areas that could be economically supplied with current for the incandescent lamp have become comparable to those already covered by water and gas.

But with the advent of the electric railroad new problems were introduced. It was not so much areas as distances that now must be covered, and with the extension of these lines to the suburbs and the growing demand for interurban electric lines these problems become more and more urgent of solution in a different and more effective manner than hitherto.

Brush stopped with his discovery of the automatic cut-out for stationary translating devices, and without an equivalent for the moving car the constant current system lacked sufficient flexibility. On the other hand, with the constant potential method it was only necessary to double or treble the potential to give equally economical distribution to double and treble the distance. Five hundred volts (about five times that upon which incandescent lamps can be used) was decided upon as within the limits of safety, and has become the standard street railway pressure throughout the country. By this means, with the assistance of feeders, even suburban requirements up to eleven or twelve miles (in one extreme instance) have been supplied, but now come the further requirements of interurban lines, which can only be met by this system by a duplication or multiplication of generating stations, with all that is implied thereby. In these longer distances, the constant potential method, if it has not already done so, is certainly beginning to trench upon a domain which does not belong to it, as we shall endeavor to show.

The problem of distributing current to moving cars by the constant potential or multiple-arc system is quite different from that of distributing current by the same method to stationary translating devices, in that the position of the load is constantly changing. The cars at times may be all bunched at the further end of the line, and the feeder provision must be sufficient to meet this contingency. If sufficient for this, it involves an investment in copper so much in excess of the mean requirements as to be a heavy burden on the interest charges. Such a heavy burden is this, in fact, that, when the distances exceed eight or ten miles, it is usually deemed more expedient to erect a second station, with all that that implies, than to make use of sufficient copper to overcome the drop that would otherwise result.

It will be evident that in calculating the copper for an installation of this kind, having a constantly varying and shifting load, the best we can do is to proportion it to certain ideal requirements, which may in practice be met only once or twice in the day's run. For all other conditions the amount of copper employed will not be that which will meet the requirements of maximum economy.

In the multiple-arc system it is dangerous to reverse the direction of motion of the motor while the car is rapidly moving, and hence advantage cannot be taken of electrical braking except in cases of emergency. The moving car is always checked by mechanical means, and in descending a grade its energy of position is entirely frittered away in heat on the brake shoe and wheel-tire.

The single trolley is all but universally used, thus making the track and earth a part of the circuit. This introduces an element of uncertainty in the circuit which can never be provided for adequately by the overhead system of feeders and trolley wire, and one which has caused no end of annoyance. When the ground is soaked in water, the resistance of this return is almost negligible, but when it is dry and parched, or when the track is covered with dry dust or dry snow, it may increase to almost any extent. To obviate these difficulties some companies have actually spent more money in the ground in the attempt to give a uniformly good return to the current than they have spent in their feeders and trolley wire overhead, and yet have failed to obtain an entirely satisfactory result.

Since the electric car has become almost universal in our larger cities a new and equally serious objection to the ground return has developed, in the corrosion of the gas- and water-pipes and metallic sheathing of cables buried in the ground, due to the electrolysis caused by the large currents. This has been especially noticeable in Boston, Cambridge, and Brooklyn, and no adequate remedy has as yet been devised, nor does there seem at present to be any remedy other than the radical one of abandoning the earth entirely as a return and resorting to the double-trolley system. The question of damages for the destruction of water and other pipes by the return currents from electric railways has not yet come up before the courts, but it would certainly seem that the trolley companies should be held responsible in equity if not in law. It behooves us, therefore, to look about us for the means of abating that which is not only a nuisance to ourselves, speaking as street-railway men, but an injury to our neighbor, and it is for the purpose of calling attention to a system which appears to meet all the requirements that this paper has been undertaken.

Brush solved the problem of supplying arc lamps arranged in series on a constant current circuit. He did not go into the street-railway problem on the series method, but his successor, Professor Sidney Howe Short, made a most determined effort towards its solution and actually constructed and operated for a time two small roads on constant current circuits. While his plan proved a failure as a practical system, the results obtained were exceedingly instructive, and demonstrated that, if the series system could be made as flexible as the multiple-arc, it would possess many features of economy, both in construction and in operation, to recommend it far above the latter for traction distribution.

In regard to the series system the following advantages have, I believe, been fully proved and are admitted by all :

I. The installation of the power-station is by far simpler and less expensive than that of a station on the multiple-arc plan.

II. Where high potentials are used, as is necessary in long transmissions, both the dynamos and motors are smaller and cheaper to build than those of the same capacity suitable for constant potential circuits.

III. The amount of copper required for transmissions of equal amounts of power to equal distances is considerably less in the series system, and its weight, having been once determined to best meet the question of economy, continues to meet that question equally well, whether there be one car or many on the line and whether the line be one mile in length or thirty. In fact, since the current remains the same, the question to be solved always is merely what size of wire will, all things considered, most economically carry that current, and this will be determined and hold good irrespective of the number of cars, the length of the line, or the position of the cars on the line. In the multiple-arc system (that now in universal use) the same economy could be obtained only by varying the copper with the constantly-changing position and demand of the cars, which is, of course, an impossibility. In the series system it is obtained by simply varying the electromotive force of the circuit to meet the ever-changing conditions, and this is automatically attended to by the dynamo itself.

IV. It is in many respects safer, for, while high potentials are used in the series system, they are confined to the terminals of the dynamos in the power-station, and the potentials at the car-

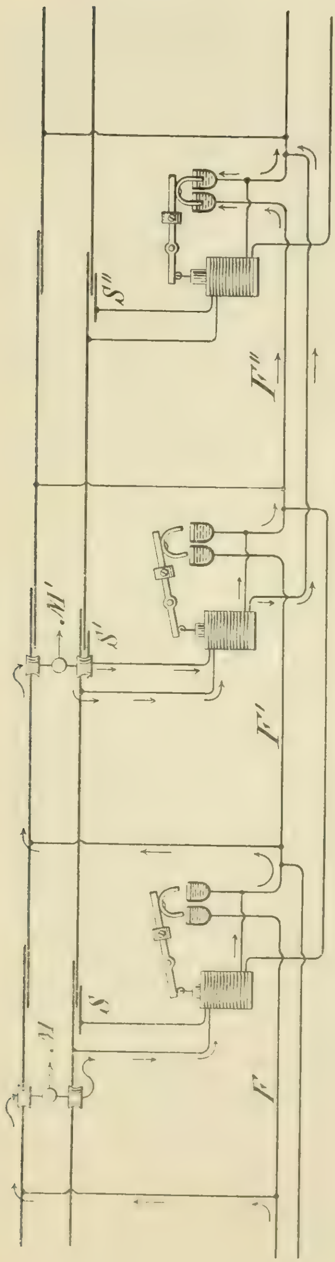


DIAGRAM NO. 1—FEEDER SERIES SYSTEM.

terminals are only proportional to the work which each car is doing at the time, while in the multiple-arc system the high potentials extend to the terminals of every motor on the line, irrespective of whether it is doing much work or little.

The other advantages will be mentioned at the proper place in the description of the method which follows.

In a system which has been devised recently the main features are that a system of feeders is employed as in the multiple-arc system, which, instead of feeding amperes into the trolley wires as in the latter, feeds in volts or electromotive force. This may seem to be a rather strange statement to make in regard to a series system, but it will be better understood by reference to diagram No. 1. $F\ F'\ F''$ is the main circuit or feeder wire, normally electrically continuous and independent of the trolley wires above. It is, however, divided into sections, each of which is terminated by a mercury cup into which take the copper forks by which these sections are normally connected electrically. The two trolley wires—for this is a double-trolley system—are also divided into similar sections or blocks, the adjacent ends of both wires of adjoining blocks being lapped, but insulated from each other, and the laps are staggered as shown. The further trol-

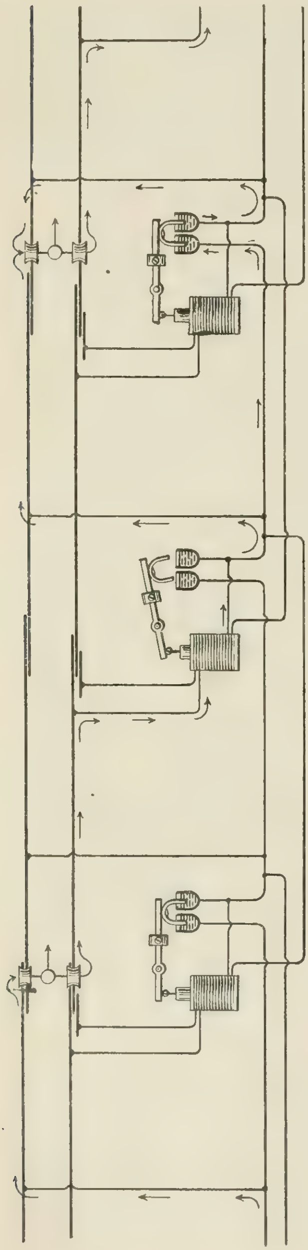


DIAGRAM NO. 2.—FEEDER SERIES SYSTEM—BLOCK TRANSITION.

ley wire of the block is directly connected with one section of the feeder, and the near wire is connected through the coils of an electro-magnet with the succeeding sections of the feeders.

Also parallel to the nearer lap, and anticipating it a little, is a short subsidiary wire *S S′ S″*, which is connected with a second coil of the same magnet wound parallel with the first, and which in its prolongation short circuits the mercury cups of the next succeeding section in advance. The above electro-magnets when excited raise the forks in the corresponding mercury cups, breaking the feeder circuit at that point and forcing the current to take another path. As the trolley-wire sections are normally insulated from each other, no current can ever pass through the magnet unless there be a car on that section. The car-motor therefore forms the alternative path through which the current has to pass when the fork is raised. In diagram No. 1 these features are shown together with cars *M*, *M′* on adjacent trolley blocks. The arrows show the paths pursued by the current and also how the two cars are thus arranged in series with one another.

It will be noticed that the supplemental conductors and the laps in the trolley wires are so arranged, relative to each other, that, when a car is traveling in the direction of the main current, the trolley traveling upon the wire connected with the fork or switch will contact with the supplemental conductor before reaching the lapping portion of the trolley wires, and the companion trolley will reach its lap after the first trolley has reached its lap and before it has passed beyond the supplemental conductor, while, with a car traveling in the opposite direction, the order will be reversed,—the trolley upon the wire *not* connected with the switch first reaching its lap, after which its companion trolley first reaches its lap and afterward the supplemental conductor. In this manner the transition is accomplished in either direction from one section to another, either on the same or another circuit, without spark or interruption of circuit. In fact there is here accomplished for the series railway car what Brush accomplished for the series arc lamp.

As the number of cars operated on one circuit will be limited by the potential it is deemed safe to have at the dynamo terminals, the road is divided up into as many working sections as may be

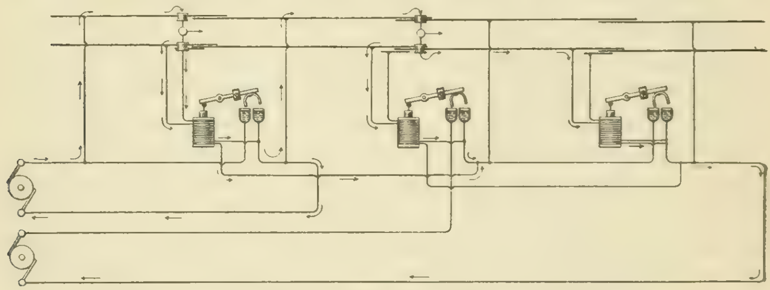


DIAGRAM NO. 3—FEEDER SERIES SYSTEM—FEEDER TRANSITION.

deemed advisable, each of these sections, one of which may consist of many blocks, being operated on a separate circuit. In this way the potentials may be kept within limits.

It is intended that but one car shall occupy a block at a time. Since the block receives current only while occupied by a car, the entrance of the car on the block may set a signal of danger, which is withdrawn on its leaving that block. If, however, notwithstanding the danger signal, a second car should run on to the block, the two would be thrown into multiple with each other and both brought quickly to rest, thus constituting this system a most perfect block system.

The series car is controlled entirely by shifting the position of the brushes. The current being constant, it is perfectly safe to reverse the position of the brushes, even at full speed. By this operation the motor is converted into a dynamo in series with the one in the power station, and contributes electromotive force to the line to the last turn of the wheels. Instead of frittering away in heat the energy due to the acquired motion of the car, as in the multiple-arc system, the car is checked by reversing the brushes, and the energy absorbed by thus checking its motion is thrown on to the line for use elsewhere or to the relief of the steam-engine. In descending a grade, too, the energy stored up in the car as potential in ascending that grade is given out to the line as kinetic energy instead of being thrown away as at present. Since in a round trip there is as much down-grade as up-grade, the track is theoretically reduced to a level, and, since the car is checked as often as it is accelerated, its motion is theoretically reduced to a continuous and uniform one, and the economies resulting from these ideal conditions are by this system and by this system alone theoretically realized. Practically, the economies of operation must be very large, though of course far short of the theoretical.

One of the greatest doubts that I have had in regard to this system concerned the ability of the generator to respond promptly to the enormous sudden changes in potential corresponding to the similar changes in current on multiple-arc roads. This doubt has been entirely removed by the experience in a series-transmission plant at Geneva, which has been in successful operation for nearly two years. Although this plant is driven by water-power, the diagrams show that, while instantaneous fluctuations of 1000 volts were frequent,—on several occasions the variation was between 1400 and 5800 volts,—the regulation was effective and practically instantaneous.

It is believed that this recent improvement renders the series system fully as elastic as the multiple-arc system, and that in view of the difficulties encountered in the latter, the growing tendency to extend electric railroads to greater distances, and especially in view of the recent decision by Judge Greene in the Feeder and Main patent, awarding the sole right to use feeders to the Edison company, aside from its own intrinsic merit, this system will soon attract the attention it deserves of the electrical public.

CITY WATER-SUPPLIES OF THE FUTURE.

By Samuel McElroy.

THE wonderfully rapid and systematic growth of population throughout the United States, and especially in the cities, makes the question of the water-supply of the future one which even now deserves earnest attention. As our municipal centers rapidly accumulate population, and the demands for food, water, light, heat, sewerage, sewage disposal, fire-service, police protection, health protection, burial, transportation, and like services increase, we are gradually forced to consider the experience and practice of the large centers of the old world, ancient and modern. And it may be taken for granted that whatever large centers of population elsewhere have found most beneficial, or imperative, in the accumulated experience of the centuries, may be found worthy of adoption by us, under like conditions of supply and demand. Unfortunately for the best interests of the nation, and of its large cities, we have not as yet fully learned to comprehend the value of disciplined professional experience in public works. Too little attention is paid to the principles of hydraulic construction and operation, established and proved by the centuries.

The United States census for 1890 shows that nineteen of the chief cities in rank—from New York, with 1,515,000, to Louisville, with 161,129, inhabitants—had an average daily supply of 104.6 gallons per person. New York had 79 gallons; Chicago, 140; Buffalo, 186; Detroit, 161; and Brooklyn, 72. The lowest rate was New Orleans, with only 37 gallons daily. The ordinary use and waste of water may be stated roundly at 100 gallons per capita per day. All this must come from the rainfall, the catchment area, the percentage available, and the quantity actually controlled by reservoir and aqueduct delivery.

If we take a rainfall annual mean of 42 inches, and assume 60 per cent. catchment available, each square mile of basin is worth 1,200,000 gallons per day, and will supply 12,000 persons with 100 gallons each. For the purpose of this paper it is not worth while to analyse relative district rains, or catchment proportions, or to discuss the popular delusion that rain-supply is diminishing because changes in basin delivery take place, or the occasional professional demonstration, in the face of experience, that 60 per cent. cannot be realized with proper outlay. It is sufficient, for the present, to assume that about 10,000 persons can be supplied by one square mile of catchment.

It is also sufficient to assume that as our large cities increase in population their ratio of increase diminishes. The growth in Brooklyn from 1860–70 of 48.58 per cent. declined in 1880–90 to 36.54 per cent. The decline in New York was from 58.5 per cent. in 1850–60 to 19.47 per cent. in 1880–90. In New York State it was from 73.1 per cent. in 1790–1800 to 18 per cent. in 1880–90. The decline in the United States, by decades, from 1850, was 35.58, 22.63, 30.08, and 24.86 per cent., respectively. If we assume, therefore, an average increase per decade of 25 per cent., in a case where it is best to estimate liberally, the population doubles in thirty years.

Applying these conditions to Brooklyn, that city will have in 1920 a population of about 1,600,000, requiring the entire available yield of 160 square miles catchment. The basin of the 12.39 miles of original aqueduct is 88.64 square miles, and that, with the 7 33 miles extension, will barely furnish the required total. New York, on the same basis, will have in 1920 3,000,000 inhabitants, requiring the full supply of 300 square miles. The entire area of the Croton basin above the old dam is about 339 square miles; the new dam will make this about 350, and the Bronx catchment is 22,—a total of 372 square miles. Boston in 1920 will have about 900,000 population, requiring 90 square miles. To the Cochituate basin of 19.72 square miles it has added the Mystic lake of 26 87 and the Sudbury of 73.73,—a total of 120.32 square miles.

Cities like Philadelphia and Cincinnati, on large rivers, draw from larger catchments, and those like Chicago and Cleveland, on great lakes, have the same advantage.

It is not necessary to extend this analysis of relative supply as to quantity available and demand. Enough has been shown to prove that within the next generation, under present practice, most of our American cities will face a very serious problem.

This problem, at the outset, has to admit an integer in the equation which has not been properly recognized by our hydraulic engineers or city authorities. Whatever may be the available catchment of any supply-basin, this basin is itself accumulating a population and a supply demand which must directly interfere with that of the distant city now appropriating the flow.

In the active and prolonged discussion of the Quaker Bridge dam on the Croton river one of the objections made was the neglect of proper city jurisdiction in the valley. Of 339 square miles of area the city had lease-control or actual ownership of about 6; and with 361 square miles at the new dam, it would control not more than 16 or 17. The argument was conclusive that the owners of this area had a constitutional right which the courts were bound to protect to the first and full enjoyment of the rainfall, stream flow, domestic, factory, sewerage, agricultural, and other water-rights, on their own property, for their individual and collective use.

Brooklyn, in actual fee, owns a very small area of the catchment—less than one square mile. Its supply differs from the Croton and many other surface-flow catchments in that about one-quarter is surface-flow; another comes from outcropping springs near the aqueduct, and about one-half from deep tubes of driven wells along the aqueduct. Boston and many other cities depend on surface-flow of their basins.

This brief but explicit examination of a simple question of available supply for the present practice of use brings us face to face with the conclusion that for many of our cities, some time before 1920, the interferences alone will seriously tend to reduce supplies from the basins used. To continue then a daily supply of about 100 gallons per person cannot possibly be kept up as a rule. There are here some valuable lessons in European practice as to economy or control of use.

Rome, about the time of Christ, as a city of luxuries—the public baths being prominent—had built nine costly aqueducts. About eighty years after Christ, for a population of about a million, the supply is estimated to have been 196,000,000 gallons per day. In this supply not only was great care exercised in selecting the sources, but, along the aqueducts, as in the city reservoirs, special provision was made for depuration by aëration, and by bottom blow-offs. There was a marked difference in the use to which these several supplies were applied—some being more potable than others—and in the maintenance of their available heads in the city. The distributing reservoirs were 27.4 to 158.8 feet above the Tiber. For the best supply the Aqua Marcia, collected from mountain springs, was brought sixty miles. About A. D. 60 Rome was taught our lesson of the coming generation, since the local property-owners appropriated the water-supply to their own houses and gardens.

London, at present, draws 55.5 per cent. of its supply from the Thames, 25.2 per cent. from the Lea, and the balance from springs and wells. In July, 1893, it used 199,563,488 gallons, or about 37.1 per person. The mean use in 1890 was 30.93 gallons. It has been estimated that there is available, in its vicinity, in this way, about 425,000,000 gallons per day; the catchment of the Thames is 3086 square miles, and the Medway, to which alternate resort is contemplated, has 481, with a mean annual available flow of about 748,000 gallons per square mile. All the supply is carefully filtered, and there is a constant tendency to improved depuration. As at Rome, the distributing reservoirs differ in level, from 82 to 400 feet above Trinity datum.

At Birmingham, England, the consumption is stated at 15 gallons per person; at Manchester, 24 gallons, and in sixteen European cities the average is 27 gallons.

Liverpool, in 1892, introduced a new supply from an artificial lake in Wales, at an outlay of $10,390,000. The aqueduct is sixty-eight miles long to the Prescot distributing reservoir, the distance from Lake Vrynwy to the Town Hall being seventy-seven miles. The lake basin covers 29 square miles, of which the city has purchased 22.55; in addition, two small basins and reservoirs, of 8.12 square miles are used. This basin has a large rainfall, 49.63 to 118.51 inches, with only 30 at Liverpool. The contemplated draught is 40,000,000 gallons per day, to be maintained by the storage of 12,131 millions. The question of local demand has been respected here, and a flow of 10,000,000 gallons daily must be made to the Severn valley, from the lake, with an addition of 52,000,000 for thirty-two days, between March and October. The present population is 800,000, and the supply in 1874 23.8 gallons per person.

Paris, in 1869, was using 28 gallons daily per person; in 1884, 40 gallons, and in 1887 about 48. The new works of 1887 were to supply 66 gallons. In 1789 the supply was $2\frac{1}{8}$ gallons.

In direct distinction from the large European cities of to-day, with about 30 gallons per person as an ordinary provision, the supply in the chief cities of the United States—not less than 100—invites serious examination. Water is used in our dwellings for drinking, cooking, washing, cleaning, water-closets, and bathing; in our lots and streets for fountains, sprinkling, drinking- and fire-hydrants, horse-troughs, stables, and building; in our office-buildings, shops, and churches for power; on our wharves, for steamboats and shipping; for railways and other like uses.

Brooklyn, in 1891, used, as reported, 58,025,000 gallons per day; of this, domestic purposes took about 48,361,000, and "register" and "meter" accounts, 9,664,000 gallons. If we assume charges as a fair basis of comparison, regulated on meter and other measurements, the use for other than domestic service was about as follows: for factories, 54 per cent.; miscellaneous, 30; bars, 6; stables, 5; steamboats, 2; and building, 3,—this division accounting for 16.65 per cent. of the total. In domestic use, evidently, the personal item is small for drinking, cooking, and laundry; and, distributed over a whole city, the relative use for closets and bathing is small.

Drinking, washing, kitchen, and laundry requirements could well be met with nine gallons per person; whether the comparatively restricted use of closets and baths need double this quantity is a question. For fires the time of use is limited, and the supply comparatively small. In 1890, the daily average was 3.4 fires, amounting—for two hours each, for three engines, at 800 gallons per minute—to 326,400 gallons. At twenty gallons daily for house use, for 850,000 population, the daily amount is 17,000,000 gallons; fires, 350,000; street-sprinkling, etc., 250,000; extras, 9,664,000; total, 27,264,000, or about 32 gallons per person,—an estimate which London experience abundantly justifies.

If we press this analysis a step further we find a waste as wanton as it is costly. In our kitchens the presiding angel, born poor, with the instincts of poverty, when surrounded by luxuries grows fancy-rich on what she can waste. Coal, wood, gas, food, water, clothes, crockery, somehow pay toll as they take wings. If in addition, as is so common a case, the plumbing is defective, even a small leak will waste enormously every day. In hot weather the water is run to cool it and in the cold snaps it is run to warm it.

A correspondent of the Brooklyn *Eagle*, November 28, 1892, calls attention to a saloon and contiguous waste of about one gallon a second; to a leaky hydrant running a constant one-inch stream for years; to another like it; to a flowing car-stable penstock; to a bath-room faucet five years in flow.

The underground wastes are also formidable, as all the sewers prove. Cast-iron water-mains crawl more or less under temperature changes, and the joints frequently show leaks; settlement of bed, heavy trucking, etc., have the same effect; undiscovered flaws leak, and gradually oxidized and tuberculated surfaces leak in time. Any water-purveyor's report, faithfully made, tells the annual story of serious waste. In department extensions serious increase of waste may follow a change in a carefully-studied system of distribution. In 1892, for Brooklyn, a single change of this kind raised the increased mean supply or waste from about 3,000,000 annually, from 1887 to 1891, to 9,511,649 in 1892.

Evidently, then, the impending strait with which another generation is threatened requires an exercise of common sense in reducing this waste. It would be better to introduce house meters, with some obvious objections, than to continue this waste. And if our waterworks officials will stop the use of meters built like pocket watches, where simpler and more durable ones, registering within 5 or 10 per cent., are just as effective, one serious cost objection would be early removed ; but before that careful inspection would remove a number of flagrant losses.

Salt-water supply on or near all tidal fronts would furnish a direct, valuable, and inexhaustible supplement for city use, and for a large number of cities this use will become imperative in time, and should be anticipated. For bathing, water-closets, street-sprinkling, sewer-flushing, fire-service, and power it has special advantages, from its chemical constituents, purity, temperature, frost standard, and greater weight.

In 1876, at the request of Commodore Levy, U. S. N., the writer made an argument before a committee of the New York common council, comparing the economy of pumping salt water with the then proposed expenditure of $19,000,000 for the Croton aqueduct extension, in a case where a control of but 200,000,000 gallons per day was estimated as available, and where insurance-men strongly advocated its use for fires.

Of course this involves a special pumping and distribution system, but in the best days of Rome the advantages of distinct systems of reservoirs and mains were recognized for supplies of different potable value. The cost for a city like New York is moderate as compared with gravity outlays. An entire distribution of 600 miles, at present prices, would not exceed $5,000,000. For pumping plant, assuming 60,000,000 gallons per day for a population of 2,000,000, about $1,000,000 would be the cost. The original Croton supply cost $11,453,000, of which, at high prices, the distribution cost $1,877,000 ; and the new aqueduct, of 300,000,000 gallons capacity it cannot secure, controlling only 115 feet city head, has cost about $25,000,000, which the new dam will make about $35,000,000. As to operating expenses, the item of interest makes pumping with economical engines much cheaper than gravity, and any desirable head is available. If it is objected that our cast-iron mains will not answer, proper lining and coating will in time improve them, as is now needed for fresh-water use, and as our engineers gradually ascend to the cement practice of the ancients, and dismiss the latest theory that tar-palliated mains are indestructible. If the actual potable domestic supply is brought within ten gallons per person, as analysed, the range of tidal supplement becomes very important.

In our present practice no distinction is made, as in Rome, as to the several uses of the supply. Whether the water is to be imbibed by an invalid or to wash a wagon wheel, equal care or want of care is given to its quality. Under this system a contingency in our suburban catchment-basins, entirely independent of rainfall quantity or interception, arises from its immediate contamination from local influences.

At present, surface water flow, especially in storms, over manured fields, through swamps and other conditions of exposure, is more or less charged with live, dead, or decaying organic matter, as analysis shows in part and the microscope more clearly, and as the universal process of "fermentation" proves. There is also, as population increases, an increased factory and sewage contamination, and to some extent there may be disease-pollution.

While with proper reservoirs storage and depuration, with stream flow and aëration, the underground bacterial action and that of carbonic and other acids exercise a wholesome effect, no student of the future of our water-supplies, recognizing the legitimate first claims of local population in use of its own conditions and privileges, can fail to see that all our supplies must be artificially depurated, as a rule, before distribution. There are various advantages in this, and properly applied it assists essentially in the solution of freeing our available catchment supply from contamination. This applies to surface-flow, to rivers, and other bodies of water, undergoing gradually increasing contamination.

It is now well understood that while reservoir filtration materially improves potable quality, it does not effectually remove organic solutions or disease germs. That portion boiled in cooking, for personal use, is much more improved. Much attention is therefore being given to chemical depuration.

Already many cities of comparatively small supply are doing this; the urgent necessity of effectually restricted waste gains force in such cases. One sees, on a turbid, yellow, southern river, a tank-house, where dirty, swirling water, passing for a few feet through its chemical and mechanical process, becomes beautifully transparent. If the powerful agents used are not too rapidly absorbed, injuring potable quality, not only is the problem of complete depuration solved, but the contaminated outflow of a populated district can be freely used without apprehension. So a simple use of nature's powerful depurative, iron oxid, as at Antwerp, has proved a rapid and effectual "cure" for organic matter.

The obvious advantage of distinguishing between the potable supply, with its minimum proportion, and that in which chemical depuration, or even filtration, is not necessary, will force itself on engineers in designs for future supplies; and this suggests that the most radical and economical method is to depurate what is actually imbibed, not in the reservoirs, but in our houses. This properly should come under some wise and effectual health regulation, but it is comparatively easy to accomplish that.

In conclusion, this study makes it plain that our large cities cannot much longer ignore the lessons of European experience and practice, and must in time provide better for the future. While it may be Quixotic at present, to reduce water waste 70 gallons, 50 can be gained by proper care. Until recently Brooklyn consumed 54 gallons.

The first duty of an engineer, then, is to put at the service of his clients the best experience of the past, and improve on it if possible, but never ignore it. The worse than useless waste must be prevented, first by rigid inspection, next, as needed, by the meter. With this should come judicious control of the catchment areas. For fire-service, power, and other uses, head is valuable, and for economy, distribution under different heads is important. A direct depurative distinction between what we are to drink or otherwise use must be provided for, and on tidal fronts the eventual use of salt water is to be anticipated.

FLORIDA'S GREAT PHOSPHATE INDUSTRY.

By Alfred Allen, M. A.

IN the early "eighties" the pendulum of Florida's prosperity swung back, in its recovery from negro rule, and an excited crowd whose fixed idea was "oranges" rushed in from the north. Many a man without the capacity to make a living at home was supplied with cash by his too-willing family and sent to this State, though as unfamiliar with its soils as a polar bear might be. It was thought that by sticking an orange-tree anywhere in Florida it would be paying within three years at the rate of a thousand dollars per acre of trees. Nature, in her processes of selection, has a way of her own in fool-killing. Thus, by the "big freeze" of 1886—which, next to "the war," is the chief date in "cracker" chronology—she sent back home from Florida, afoot, a host of poor business men. Without exception these became enemies of the State where they had learned their own want of judgment.

There were some new settlers, however, who had fallen upon the right kind of soil, and who remained and prospered. Then came the newspaper fright over yellow fever, and those who had been caught in the chill shrieked, too. In countries where that disease is ever present it is not so much dreaded as small-pox; but in the United States, on account of its rarity, it becomes a bugaboo and a tempting morsel for the reporters. So it happened that, in the last of the "eighties," Florida was in a bad way. She had received what real-estate men call "a black eye." Taxes were hard to collect and tens of thousands of acres were allowed to go for the dues. When the reports of large profits from the sale of Florida lands to mining companies were first telegraphed around the world, many people knowingly winked, as if to say "we're too old birds for that," and they left the profits for others to reap. Men in the fertilizer business were on the doubtful side and the hardest to convince. Even to day there is doubt on the fair name of the State, due to over-booming, for which reason all the figures here given have been selected from the most trustworthy sources. The accompanying illustrations have been made wholly from photographs, as one wishes to err toward the conservative rather than the opposite pole, if he should happen to err at all.

A VIRGIN OUTCROP OF PHOSPHATE ROCK IN THE PINES.

Now that the phosphate industry has proved remunerative to those who have brought business ability, experience, and sufficient capital to carry cargoes across the sea, the exact figures are interesting, for they convince the world that Florida is not all a coral-reef or barren sand, but the home of an important mining industry. The State has taken place as the producer of an article as staple as coal or iron, and one which is indispensable to modern agriculture.

Let us glance at the statistics of the industry. In 1888 Florida showed but 813 long tons of phosphate to her credit as a mining State. In 1889 the figures jumped to 3780 tons; the "three-year-old" record was 52,381 tons; while in 1891 we saw the bulletin score 181,316½ tons. The year 1892 showed the remarkable production of 354,327 long tons, while that of the past year reached nearer 400,000.

The South Carolina industry began by a shipment of six tons in 1867. Her largest record—586,758 long tons—was shown in 1890. Owing to the inroads made by the competition of Florida river-rock, this dropped off to 548,396 tons in 1892. The year just past will show a still greater decrease, making the figures of the two States nearer even, owing to the disturbances by the cyclone, when the ill wind that bore her so much harm brought better prices and demand for Florida river-rock to fill the loss.

It is too early to calculate fully the effects of such a tide of labor

IN THE TRACK OF THE PHOSPHATES PROSPECTOR THROUGH A FLORIDA FOREST.

PROSPECT TRENCH AND SHAFTS AT ROCK SPRINGS TRACT, FLORIDA.

and capital as is necessary to carry on an industry of such magnitude as that of phosphate-mining in Florida, but the importance to the State of this discovery and phenomenal development in her borders is being forcibly impressed upon the minds of the most skeptical. Towns are growing fast at mining centers, about which are scattered the plants whose machinery and outfits have cost more than $3,000,000 and now employ 4000 men. Stores are springing up at cross-roads, with tempting displays of goods to cause the tide of the week's pay-roll to ripple over their counters. Millions of dollars have come into the State to pay for the 200,000 acres of land held by mining companies, and taxes are easier to collect and owners of land easier to find. Already Florida is the paying teller of $5,000,000 yearly which is brought in by the sales of her rock.

Wild lands are considered a more solid investment, for railroads are being built and harbors deepened to accommodate a commerce less ephemeral than that of the yearly tourist crop. There had been invested, up to the end of 1892, $635,950 for spurs and side-tracks on Florida railways to accommodate the phosphate trade, making 149 miles of steel track built for this purpose.

Although railways run to millions, and mining companies are annually spending hundreds of thousands in labor and machinery, we note with pleasure a more general asking of the question among farmers : "We have the soil and raw phosphates which are enriching the whole of Europe ; why not mix the two and have the best crops ourselves ?" But a day's journey of a mule from every one of these mines, which extend for 300 miles through the highland portion of Florida, are tens of thousands of acres which could be made a flourishing garden for all early crops. Already this is done near a few mines, and wonderful results are obtained by the use of that soft phosphate which the mines are selling at less than a quarter the price of the same value of phosphoric acid when made into commercial fertilizers. The French, who are the best farmers in the world, use more than 200,000 tons of ground phosphate each year. When Florida farmers learn to take the riches at hand, and accept Dr. Shepard's advice,—"put all the money you can spare into soft phosphate and spread it on your land,"—then will Florida sand rise from the dead, as it were, to a vigorous life.

All our farmers do not yet appreciate the fact that in a commercial fertilizer it is soluble phosphoric acid for which they pay, and not red labels, but this they are gradually finding out. As soon as they are convinced of its truth, they will demand high-grade goods, and Florida is the State where these can be found and furnished. Then will be confirmed the words of Professor Sharples, in the Boston *Herald*, in speaking of Florida phosphates : "In my opinion it is the greatest industrial discovery that has been made

SPRATT TRACT—OVERBURDEN REMOVED, READY FOR MINING.

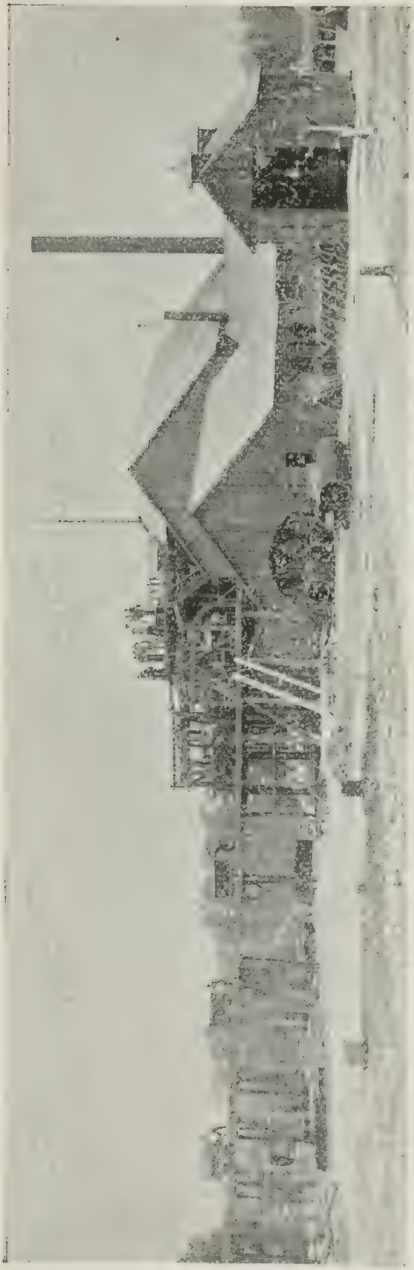
80-PER-CENT. MARION PHOSPHATE ROCK BEING SUN-DRIED, AND SCREENING FINE GRAVEL TO KILN FOR BURNING.

for many years, as well in the matter of its vast extent as in that of its high grade of richness."

It is one of the greatest phenomena of this land of the free that our agricultural class, who are convinced that they can decide the weightiest questions of silver, tariff, or international policy, do not seem to know, though purchasing 1,500,000 tons of fertilizers yearly, that what they should buy and *do* pay for is phosphoric acid *available* as plant-food. The European grower knows this full well and is protected by his government, which makes the manufacturer of superphosphates responsible if the goods are not equal to the guarantee. It also makes the manufacturer liable for the expenses of the analysis, to show whether or not the goods are up to the label. The average commercial fertilizer in the United States has but 8 to 10 per cent. available plant-food of this kind, and when it runs over the manufacturer fills the bag with sand, to keep down the grade, as there is less money in it if raised. Abroad the educated farmer gets 17 to 18 per cent. of immediately available phosphoric acid in his fertilizer, and no sand, at the maker's risk. To make this high grade of superphosphates a phosphate holding, at the minimum, 75 per cent. of phosphate of lime is essential, and Florida produces this grade.

In the last year Florida sent abroad more than 200,000 tons of this rock to enrich the soils of Europe, which used nearly 4,000,000

MINING FORCE OF THE COMPAGNIE DES PHOSPHATES DE FRANCE.



PLANT OF THE COMPAGNIE DES PHOSPHATES DE FRANCE.

tons of commercial fertilizers. That golden time must come when that great grumbler, the American farmer, will learn better, and begin ciphering out his problems on his children's slates. He then will demand that, when he pays for phosphoric plant-food to replace that which his wheat or other crops have taken from the home-place, he be given, not the name "guano" on lime or sand, not lamp-black and a smell as at present, but available phosphoric acid, and will hold the manufacturers responsible for its delivery. With that better day of his emancipation from corner-store politics to the liberty of common sense will dawn the real development of Florida and her phosphates, which alone can be used to make what millions will demand and insist that they receive—to replace the 2,714,585,473 pounds weight of phosphoric acid yearly taken from the land in the United States by its cereal crops.

There are many different theories of the source of the phosphoric acid in the phosphates, but to the practical miner little matters except the fact that in some way the phosphoric acid came, was leached into the limestone, and replaced the carbonate with phosphate, and left him his "hard rock," "gravel," "plate rock," "soft phosphate," "land," and "river" pebbles, which he must properly mine and prepare for market. How to do this is what worries him most and makes a rich harvest for the machinery manufacturers. Roughly speaking, phosphate mining can be divided—as we were taught in childhood to divide the earth—into land and water. The land mining is further subdivided into "boulder," "gravel," "plate," and "soft" deposits; the first being handled as heavy materials must be which need blasting and crushing, to be reduced to sizes which can be handled conveniently; and all methods are but variations of those used in the hematite iron-ore workings. The other deposits can be worked more by the wholesale methods of steam shovels or dippers, and even hydraulic washers are successful, as used in the gravel workings of California.

The mining under water follows the lead of that of the South Carolina river mining methods, with all forms of dippers, shovels, pumps, and grapples.

The hard rock or granitic boulder forms are often as beautiful as

MINES OF THE COMPAGNIE DES PHOSPHATES DE FRANCE.

TYPICAL GRAVEL-KILN AND SHED AFTER BURNING.

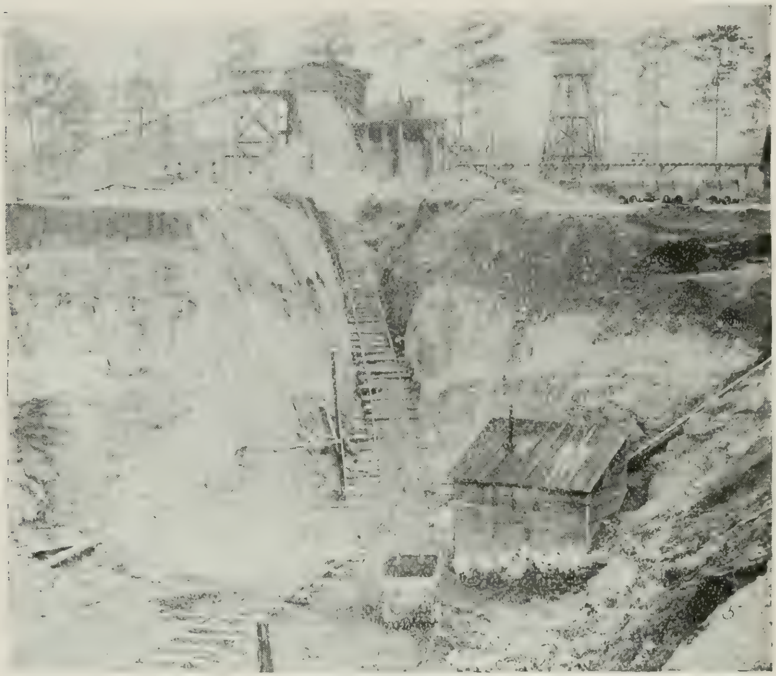
marble or agate in cross-sections, and the deposits usually begin at the outcrops and run back under the sand overburden to great depths. The overburden is rarely taken away deeper than fifteen feet, but profitable mines have been at work in sixty feet of high-grade rock. The Dunnellon Phosphate Company has removed over 60,000 tons from one open cut of an acre in extent. The deposits are pockety in all cases, being from a few square yards in extent to three acres, the size being often in inverse ratio to that of the out crop.

Liebig has said that "a nation's civilization may be estimated by its consumption of sulphuric acid." Dr. Charles U. Shepard gives the following valuable table as the world's use of commercial fertilizer,—that sponge which absorbs so much sulphuric acid :

	Tons.
United States	1,550,000
Germany	1,300,000
France	1,000,000
Great Britain	1,000,000
Belgium Holland (estimated) 300,000 Scandinavia " 100,000 Spain, Italy, Austria	650,000
Total	5,500,000

Thus we see that, according to the test of the first authority, America would lead the civilization of the world. To the making

WASHERS, COMPAGNIE DES PHOSPHATES DE FRANCE.



A DEEP MINE.

of this vast total the following countries contributed, in 1891, by the tables of Mr. Hermann Voss :

	Tons of 2240 Pounds.
France (Somme and Ardennes)	400,000
Belgium (Mons and Liege)	200 000
West Indies (Aruba, etc.)	50,000
Canada	20,000
Germany (Lahn)	40,000
England (Coprolites)	20.000
Russia, Norway, and other countries	100,000
Total	830,000

This does not include the United States, which, for that year, produced 757,133½ tons of phosphates. The figures are extremely interesting, and since that day there has been dumped into the nearly-balanced scales the great increase of the output of Florida ; and the preponderating influence in the markets of the world has come across the waters to American mines on account of this new mining State. But by forcing her way into the scales Florida rock has suffered the consequence and, naturally, gone down in price.

Before me lies an account sales rendered to a Florida mining

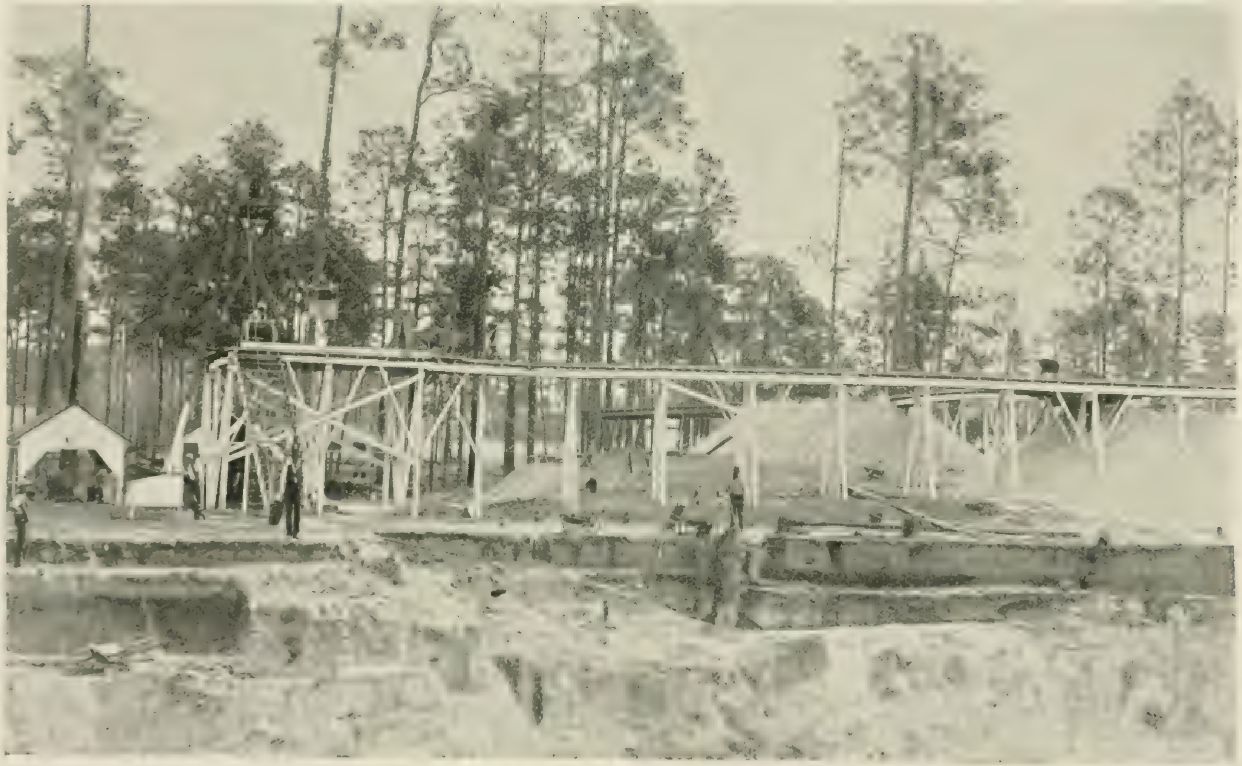
THE "GOPHER" MACHINE REMOVING OVERBURDEN OF SAND.

company in the early days of the industry. The rock yielded, by analysis, about 78 per cent. phosphate of lime, which brought, at that time, 25.34 cents per unit. Thus for the total of a small cargo of 1104 tons the gross result was $32,761.17, making net proceeds $22,241.45, which is not half bad. And yet when the rock was first sold in the European market it brought 30 cents per unit.

The London market now yields 17 to 18 cents per unit, which nets the miner from $5 to $6 on the cars at the mine. To meet this sudden drop in the scale, and yet live, has been the problem of the field. At first we saw hundreds of thousands of dollars recklessly thrown into plants whose washers, driers, cableways, engines, and houses were found totally impracticable, and were soon abandoned. It speaks well for the industry that it has lived and thrived even against odds which would have killed any business that did not have the elements of a most vigorous growth. For instance, the output of one mine was 25,000 tons one year, and in that time the salary-roll reached $50,000, and machinery and prospecting each cost as much more.

The business is not old enough to have developed any one method as the most profitable in all respects, so that each mine has its own individuality and peculiar method of working. In the field are miners and companies from France, Canada, Germany, England, Spain, Holland, Belgium, Algeria, Norway, and all parts of the United States. All systems are in use, from the negro with his "buggy"—as he calls a wheelbarrow—to the complete plant, where the rock is not touched by hand from the time it leaves the pit until it is in the box-car,—washed, dried, sorted, and ready for the Hamburg manufacturer of superphosphates.

There is no sign of exhaustion in the deposits. Florida rock has crushed the Spanish phosphate industry and also that of Canadian apatite-mining, which once were the only sources of that high content of phosphoric acid essential to the manufacture of the high grade of fertilizer demanded by the educated European farmer. The United States government experts estimate that the South Carolina mines, which have made Charleston the financial hub of the south, will become exhausted in twenty-five years. Though they unfortunately estimated the number of tons in sight in Florida at 133,056,416, it is fortunate that the whole State is not solid phosphate, as was believed by those who went crazy in the "boom" of 1890. After all, there is enough here to give her an income suited to a princess of phosphate States, and that for centuries to come.



THE WIRE-ROPE TRANSPORTATION SYSTEM IN USE.

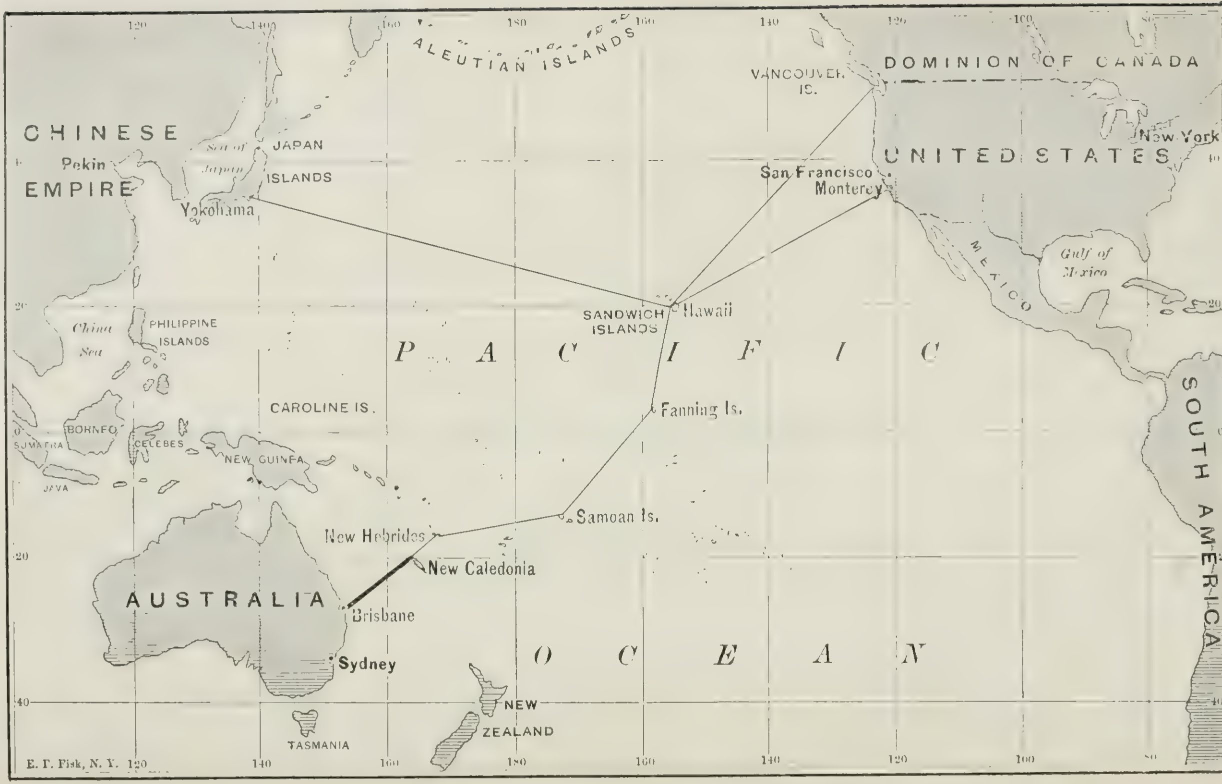


CHART SHOWING ROUTES OF PROPOSED PACIFIC SUBMARINE CABLES.

[The heavy line leading from Brisbane indicates a section of cable now in operation.]

PROPOSED CABLES UNDER THE PACIFIC.

By Herbert Laws Webb.

CABLE-LAYING contractors have for many years cast longing glances at the Pacific ocean,—the one great gap in the submarine-cable system of the world. From the contractor's point of view the laying of a cable across the Pacific would be a splendid job, provided that a company of unquestionable financial responsibility were in the position of "the party of the first part." The party of the first part has not yet appeared in a really satisfactory guise, and the Pacific cable so far has only found an easy, though unproductive, resting-place in the columns of the newspapers. Lately, however, a beginning has been made,—at the wrong end of the line, it is true, and of insignificant size, but still it is a beginning,—and many signs now point to the completion in the near future of a Pacific cable.

It is safer to say *a* Pacific cable because, although it has become customary to speak of *the* Pacific cable, the routes and termini proposed by the different nations and individuals interested offer as much variety as is found among the routes and termini of the cables that cross the north Atlantic and south Atlantic between the American continent and Europe and Africa. For example, Vancouver and Monterey are almost exactly as far apart as Valentia and Lisbon, the European termini of the north and south Atlantic cables; while Yokohama and Brisbane, both proposed as termini of "the" Pacific cable, are a great deal farther apart than Heart's Content and Pernambuco, the American termini of the north and south Atlantic cables.

As matters now stand there are really two distinct schemes on foot for cables across the Pacific: one, which may be called the American plan, for a line from California to Japan, via the Sandwich islands; the other, which may be called the British-Canada-Australian plan, for a line from Vancouver to Australia, via the Sandwich islands, and the Fanning, Samoan, and Fiji islands. In this latter route the Canadian government and the Canadian Pacific railway have interested themselves and have endeavored to interest the Imperial government and those of the Australian colonies, though so far without much success. The first plan was originally proposed by the late Cyrus W. Field, shortly after he had successfully promoted the first Atlantic cable, and when, like a marine Alexander, he was looking about for other seas to conquer. Ordinary coastwise cables, useful as they are in many parts of the world, were beneath Mr. Field's notice ; he looked to mooring the New World to the Old on both sides, and his proposition was really a combination of the two schemes just specified. He laid out a plan for a line from California to Hawaii, and "branches" from the latter point to Japan and to Australia, comprising in all about 17,000 miles of cable, or more than two-thirds as much as is now contained in all the systems of the North Atlantic service, with their many branch connections.

The two schemes, which for brevity's sake may be called the "American" and the "Imperial," in all probability will both be carried out. From a practical point of view it is quite certain that a single line over such an extremely long route would be unsafe. The first requisite in a telegraph service is permanence, and a service depending on a single line 7000 miles long could never be permanent. The only safeguard against interruptions is a duplication of cables, and the longer the cables the more important becomes the necessity of providing against a break-down in the service by the interruption of one cable. Whenever, therefore, a single line of cable is laid across the Pacific, it must inevitably be followed by a second line,—either a duplication of the sections of the first or a line with different termini. In no other way could a traffic be built up and held against the competition of the existing routes to the same points, which practically are never interrupted. There is no reason, therefore, why Pacific cables should not eventually be laid over both the American and the Imperial routes.

It is worth while to look for a moment at the two routes in detail. In the general newspaper discussion it has not appeared to matter much whether Yokohama, Brisbane, or Auckland were picked out for the distant terminus of "the" Pacific cable. In practice it would matter very much, as there are now more than 3000 miles of cable between Japan and Australia, and the extra rate on messages for Japan via Australia or *vice versa*, over the rate for the Pacific cable itself, would make a very material proportion of the total cost per word. Another argument for the advantage of laying cables to both points is that between Australia and Japan messages would undergo innumerable transmissions, greatly increasing the delay and the chances of mutilation.

From every point of view the Imperial route is the most attractive one. Apart from the question of joining the colonies together, it has the distinct advantage of containing a greater number of sections, which renders the line easier to operate and also gives greater opportunities for picking up traffic and subsidies. The Imperial route has five sections, none of them of extraordinary length. The American route has only two sections, one of which is of extraordinary length. The section from Hawaii to Japan will be over 3400 miles long,—nearly a thousand miles more than the longest of the Atlantic cables. Such a long cable would be expensive to operate, as the transmission would be comparatively slow, and interruptions would be very costly because the delay in effecting repairs would necessarily be great. Another difficulty is that the bottom of the ocean off Japan has a bad reputation, though possibly this will disappear before the light of a detailed survey. In spite of these obstacles that appear at present the cable will doubtless be laid ; before very long it will be a necessity of commerce.

There has been considerable discussion as to whether Vancouver or Monterey should be the eastern terminus of "the" Pacific cable. It is pointed out on the one hand that for "strategic" reasons Vancouver is preferable for the Imperial route, while as regards actual economy Monterey has the palm, as the section between Monterey and Hawaii would be at least 400 miles shorter than that between Vancouver and Hawaii. A great deal of nonsense is written about the "strategic" value of a direct line between Canada and Australia. It is nonsense because, without a line across the Pacific, there is excellent telegraphic communication between Downing street and Canada and between Downing street and Australia, and when Downing street wants to telegraph there is no anxious consultation of the tariff-card to see how much the rate is. Such talk is nonsense, again, because the "strategic" value to Great Britain of a cable across the Pacific,—*i. e.*, its value to her in time of war,—would be greatest if it were entirely owned and controlled by Americans or other neutrals. Were the cable under British ownership and subsidized by the Imperial and Colonial governments it would be cut by the power with whom Great Britain might be at war, as quickly as it could be got at, treaties notwithstanding.

The strategic value of the control of the landing-place of a cable when the rest is so vulnerable would be about on a par with the strategic value of the possession of a railway terminus when the enemy could pull up the tracks. It is well known that in 1885, when there was some little friction between Great Britain and Russia, the Russian government prepared a fast vessel with an elaborate equipment for ripping up the numerous submarine cables that radiate from London all over the world, and link British outpost with British outpost. Treaties so often become warped even on land that under the influence of sea air they would lose all shape and meaning, and the "strategic" value of a submarine cable to the power controlling it is likely to be much overestimated.

Of course this does not mean that the importance of having good cable communication with outlying places in times of peace is not of sufficient weight with the governments interested to encourage the offering of good subsidies in the case of the Pacific lines. The fact that those lines would not have the strategic value to the Imperial government that has been so freely attributed to them is only one of the factors that have prevented the project from assuming more active form before the present time. The retarding influences have been various. The principal one is, of course, the enormous cost of a system of cables that would insure permanent communication. The length of cable necessary to construct a line from Vancouver or Monterey to Brisbane is, in round figures, 7500 or 7000 miles,—the higher figure for Vancouver, the lower for Monterey. The lowest price at which an Atlantic cable has been laid is about $1000 a mile. To lay cables across the Pacific would cost rather more on account of the greater distance from the seat of cable-manufacture. The capital necessary for a single line, therefore, would be nearly $10,000,000, and, with duplicate sections, without which the venture would be of a most uncommercial nature, nearer $20,000,000. Private capital alone naturally hesitates at such a plunge, although private capital has long been willing to take it with the support of government life-belts.

The government life-belts so far have not been forthcoming, although applied for in various directions, and capital has lingered coyly on the shores of the Pacific. It has been difficult in the extreme to secure united action, or even united interest, on the part of the various Colonial governments in the face of the lack of interest on the part of the Imperial government. The project, too, has been fought by the "cable ring," which controls by far the greater proportion of the world's submarine cables, with all the ferocity, with all the far-reaching manipulation, of which that body is capable. I have heard of no business competition so vindictive and so—peculiar in its methods as that practised in submarine cable circles. It would probably astonish my readers, and lead to a suit for libel against the English publisher of this Magazine, were I to relate some of the "strategies" by which competition in submarine-cable laying and working has been accomplished. No doubt much of the opposition and lethargy with which the Pacific project has been met could be accounted for by those interested in existing lines of communication.

However, in spite of all the difficulties real and apparent, in spite of all the opposition active and latent, the Pacific-cable system will soon be in existence. There is a real demand for it, for one thing, and there is every prospect of a satisfactory and growing traffic. The necessity for the section between California and Hawaii has been obvious and pressing for some time past. Had the cable been laid a year or so ago the whole Hawaiian fuss would most probably have been averted. The saving in printer's ink and type-metal, to say nothing of editorial, repertorial, and governmental time, would have more than paid the cost of laying the cable. Had the excitement occurred in spite of the cable it would have provided paying business for the cable during all this time. The Fifty-first congress had an opportunity to ensure the laying of the cable in 1891 by granting a subsidy. It made an appropriation for a survey instead. Probably before now the Fifty-first congress has wished it had made arrangements to have the survey and the cable too. From reading the head-lines of various newspapers I am at a loss to determine which party to the many-sided dispute would have found the greatest "strategic value" in the cable had it been in working order during the past year. Certainly its value to a public already overburdened with other worries would have been sufficiently great, as cable messages are generally terse.

It is a trite and inaccurate saying that "trade follows the flag." It would be much truer, and certainly newer, to say that trade follows the cable. Of course there have been many cases where the trade was already active, with abundant traffic ready to flow into the cables the moment they were laid. But there have been many others where, languid and intermittent until the cable stretched out its encouraging and far-reaching grasp, trade has rapidly and steadily increased under the subtle influence of instantaneous communication with the markets of the world. Many instances of this could be cited, and it is an unquestionable fact that submarine cables, like long-distance telephone-lines, make their own traffic by creating new ways of doing business. In the case of the Pacific cables the places now without communication that will be opened up are of relatively insignificant resources, excepting Hawaii, and even Hawaii in ordinary times will not keep a cable busy all day. But in the aggregate the different intermediate points will probably make a fair showing and whatever traffic they furnish will surely show a steady increase.

The Pacific cables, however, will find their principal traffic through providing a more direct route between Australasia and the American continent. There is already considerable trade between this country and Australia, China, and Japan, and more direct communication cannot but give that trade a great incentive. Cables connecting America with Australia and Japan will give her quick communication besides with the Straits settlements, the Philippines, China, Siam, Tonquin, India, and Asiatic Russia. They will provide an alternate route from Great Britain to the extreme east and Australia, and other sources of traffic will be found in Canada and South America. The completion of the trans-Siberian railway, opening up communication across a vast tract of most varied resources, will introduce an important change in the channels of commerce in the part of the world that the cables will draw on for their traffic.

A word as to the practicability of the Pacific cables. The only part of which a detailed survey such as submarine-cable engineers nowadays exact has been made is the section between California and Hawaii, which has been surveyed by the United States government. The soundings made by the *Tketis* and the *Albatross*, while showing a slightly greater depth than that of the north Atlantic, have revealed no other difficulties. The banks on the line have been surveyed in detail and a practicable route laid down which shows a far more even bottom than that of the mythical north Atlantic "telegraph plateau." Captain Maury's "telegraph plateau" was outlined before deep-sea sounding had become an exact science. Since the laying of the early Atlantic cables closer surveys have discovered three important banks along the line of the "plateau" that materially disfigure the even profile it presents in the imagination of the majority of newspaper-readers. The really beautiful profiles of the Pacific from California to Hawaii that accompany the elaborate report of the United States survey show a bottom that is a delight to the submarine-cable engineer; all he could wish is that the whole of it were a little nearer to the surface.

The great depth is after all not very much of a difficulty, when the evenness of the bottom and its favorable composition—principally brown ooze and globigerina—are taken into account. Depths as great as the average of those determined in the Pacific survey are found in the north Atlantic, and especially in the south Atlantic. I know of a cable in the south Atlantic, in practically the same depth of water, that has been down for over ten years without a single interruption—and it was laid over a bank at that. The bank was missed even in a very careful and detailed preliminary survey, and was discovered while the cable was laying in sufficient time to save the situation by paying out extra slack. A large portion of the Pacific, west of the Hawaiian islands, has not yet been surveyed with any detail. There are stories of abnormal depths in these waters, probably due to drifting of the sounding line, and, as pointed out before, the seas in the neighborhood of Japan and Australasia have a suspicious reputation. They have given good (or rather bad) ground for their ill-fame from a submarine-cable point of view by occasionally shifting their bottom in a surreptitious manner. This is more than a cable can stand, and several serious interruptions have been caused by these submarine earthquakes.

It is interesting to note, in closing the subject, that a beginning has already been made, in a small way and at the distant end of the line, by the laying of a cable from Queensland to New Caledonia. This has been laid by a French company—the Société Française des Télégraphes Sousmarins—with the assurance of subsidies from the colonies interested. The cable company proposes to lay further sections to the Fijis, Samoa, the Fannings, Hawaii, and California, and is agitating for subsidies in competition with the promoters of the American and Imperial schemes. This enterprise illustrates an interesting phase of submarine-cable work. The few contractors who engage in making and laying cables are often driven, when legitimate orders hang fire, to promote telegraph schemes themselves in order to make work for their factories, fleets, and staffs. The French company is peculiarly in this position. It was started with the capital set free by the purchase by the French government of the Paris telephone system, and a large amount of money was spent in an elaborate factory at Calais, a ship and so on, reliance being placed on steady orders from the French government. This august body, exercising the privilege of governments, proved fickle to its promises or assurances and the company, being unable to compete in price on open tenders with the English cable-manufacturers, finds itself in the position of being obliged to make business for itself. Hence its appearance in the Pacific. If it be true, as stated, that this company intends to complete the line from Queensland to California on its own account (failing subsidies), one cannot but admire the company's courage. It is magnificent, but it is not business, although it may turn out to be very good business in the end—for somebody.

To sum up, there can be little doubt that the Pacific will have its net-work of cables within the next few years. Asia will be moored to America; Puck's girdle will be complete.

PRECAUTIONARY HINTS FOR INVENTORS.

By Frank Richards.

GOOD advice is the cheapest thing in the world, especially when the quality is considered. Though always a drug in the market, the production still goes on, and it is not in human nature to allow any of it to run to waste.

The United States is the land of many inventions. The remark has been made before to the glorification of American ingenuity. The inference may be correct, but the evidence does not warrant it. The greater opportunity and the greater incentive to invention here would seem to be sufficient to account for the phenomenal activity. The fact that inventions are better protected here than elsewhere, the fact that inventions are reputed to pay well, makes every man a would-be inventor ; and the final result is that while the United States is, as loudly claimed, the land of the successful inventor, it is also—alas !—the land where the unsuccessful inventor abounds. Any one who knows much about patents can recall a hundred unsuccessful ones for one that has had any measure of success, or that, as we say, has paid its expenses. Besides the unsuccessful patents we must reckon, to get a true view of the shady side of the case, the vast numbers of rejected applications for patents, and then we may look over the horde of deluded unfortunates who waste their days and their nights, their money, their friends, their hopes and their lives upon worthless schemes that never reach the doors of the patent office. Oh, yes, we are a nation of great and successful inventors. We reap a rich harvest of golden grain ; but the stubble and the straw and the chaff encumber the ground.

But why do so many inventors fail ? It is not difficult to shape an answer that will cover every case. They don't have a successful run because they stumble over an *if*. Sometimes the "if" is a little one, sometimes it is a big one, sometimes there are more than one in the way ; but little or big, one or many, an "if" is as inevitably fatal to an invention as a drop of oil is to a spider. The writer remembers how, once upon a time, in one of the cities of the Empire State, an ingenious and persevering colored man was chasing mayor and aldermen around town with his drawings and specifications of a proposed device for stopping runaway horses.

The invention contemplated the erection, at each street-crossing, of a couple of stout posts, around one of which was to be coiled a wire fence long enough to reach across the street. If a runaway should occur it would only be necessary to run ahead of the horse and unwind the fence and hitch it to the post across the street. It is perfectly evident that this device would stop the runaway every time, if—. In fact, it is to be supposed that every invention would be a success if it could satisfy a big enough "if."

About this time we are to expect the device for melting the snow in the streets. The cuts and description have lately been published of an elaborate machine for this purpose. It is claimed that the machine, employing thirteen men to serve it, will melt 1000 cubic yards of snow in ten hours, with a consumption of 200 gallons of naphtha, and with a total operating expense of $37, allowing nothing for repairs and maintenance or for original cost of plant. The writer has taken the trouble of making some rough computations upon the estimated performance of the machine and is not prepared to concede that it will do more than one-half of what is claimed for it; but, assuming that it will do all, the claim will bear looking into a little. One thousand cubic yards of snow would be about the average amount to be disposed of upon one wide street for the length of one city block after a snowfall of one foot. The water would weigh seventy-five tons. After a good heavy snowstorm, when the snow must be disposed of as speedily as possible, at least a thousand of these machines, with crews amounting to 13,000 men, and, say, one thousand "supes"—all voters—would be required to make any respectable showing in New York alone. After a "blizzard" the machines would be of no use at first, when most needed, because they would not be able to "get there." It is to be feared that *if* will be too much for this invention. Any one who has ever undertaken to get enough water to do a family washing by melting snow in a wash-boiler over a red-hot stove is not likely to be found inventing an apparatus of this kind, or even holding any stock in it.

There is no unkindness or injustice in the sharpest criticism of any invention that challenges our attention, provided that the criticism be honestly given, and that it be based upon sincere and intelligent conviction. Where a thing is a self-evident and inevitable failure the mistake and the cruelty of silence rather than condemnation, though often practised in such cases, means only the attempted prolongation of a necessarily mortal agony.

The fact that a man sets himself up for an inventor, or assumes that he is one, affords no presumption as to the fact. I have had a man talk to me as much as would fill two pages of this Magazine to explain how a rack and pinion works, and I actually believe that he thought while talking that he had invented that mechanical movement. It is well-known to any one who has had much experience in mechanical lines that there are very loose ideas widely spread as to what constitutes an invention, and it is notorious that many of the inventions of the age, and often the commercially successful ones, are not the product of their supposed and accredited inventors. The writer was connected for some years with a well-equipped model-making and experimental machine-shop, where many mechanical inventions were perfected and knocked into practical shape. Some of them were more than perfected. The shop attained—and maintains—locally, at least, quite a reputation for its facilities in this line, and inventors would sometimes come there with a bare idea that a machine might be made to accomplish a certain purpose, but without a shadow of an idea of how it was to be done, and often without a mechanical idea of any kind, and they would go away with the perfected machine and swear to every detail of it, upon which a patent claim could be allowed, as their invention, and get the patent, when in some cases they were almost incapable of understanding the operation of the machine. I could tell how a quite complicated and reasonably successful machine was invented and made up, one movement after another, after daily sessions continued for some months between say, Jake, the "inventor" of the machine, and Aleck, the designer and draughtsman of the establishment, and while the machine was in progress I have more than once heard Jake remark, concerning some movement involved in it, "Well, if that device won't do it Aleck must get up something else that will"; and of course Aleck did get up something else when it was needed, and of course Jake went before the patent office as sole inventor and got his patent unchallenged. Now I am not saying that there is anything wrong in all this, except in the looks of it, and a mere matter of taste is not a thing to quarrel about. It is good for the public that Jake and Aleck got together, and it is to be supposed that they were glad to meet each other. The greatest good of the greatest number does not always mean exact justice to everybody, however.

Inventors looking for success need constantly to be reminded of some of the conditions upon which alone it is to be attained

The "business end" we so often hear of is the principal end. It is, in fact, both ends, and includes the whole. In old times, in the shop, when a gang was called to carry a heavy bar of iron, I always liked to get in the middle of it, because I knew that if the ends were kept up I would surely be all right. I was wiser in my generation than the average and typical inventor. He tugs away at the middle, indeed, but he leaves the ends unprovided for. It seems almost absurd to have to tell an inventor that it is fatal to neglect or despise the business end. Such a neglect should be taken as a reproach upon the actual inventive skill of the inventor, and involves in fact a leaving out of an essential part of the actual invention. It is not an improved valve-motion that you are trying to invent, and you know it. You are really trying to invent a thousand dollars or ten thousand dollars, and if you don't get the money it would be absolutely correct, as far as your original intentions are concerned, to say that the valve-motion does not work, no matter how correct mechanically and admirable otherwise it may be. The successful inventions of the age have been more notable as business successes than as mechanical achievements. The Corliss engine might quite possibly have died unknown but for bold and novel and correct business methods for pushing its sale. The Westinghouse brake is another notable business triumph. The marvelous genius of Edison only makes things possible; it is business organization that brings them to man's use and enjoyment.

I may now say a word or two about the most prominent invention of the year 1893, premising it all with the remark that it was not in a correct sense an invention at all, and that it was not invented by the reputed inventor, but that it well illustrates the supreme importance of attention to business. Of course the biggest thing of the year was the World's Columbian Exposition, and the biggest thing of the Exposition,—the thing most widely known in connection with the Exposition, the thing that you would first and instinctively suggest as most prominent, the first to leap to your lips when challenged,—was the Ferris wheel. Now it is telling no secret and betraying no confidence, it is with no intention of stirring up jealousies that do not exist or making any kind of trouble in the family, that I call attention to the fact that the Ferris wheel was not the creation of the Ferris brain. There was nothing that we think of as pure invention in the wheel; there was no new principle and no new application of known principles. Its construction was the successful solution of a problem of design difficult only by reason of the size and weight and strain involved. The material used was such as in these days is readily available to the hand of every constructive engineer. The greatest achievement of engineering was in the financial engineering, and that principally at the beginning of the undertaking.

The most difficult, if not the only, bit of actual invention involved in the whole undertaking was in the devising of the necessary formulæ for calculating the strains upon the wheel and for proportioning the several parts to sustain them. The work of computation, of designing the structure and the operating machinery, and of supervising its construction and operation fell upon the shoulders of Mr. W. F. Gronau, a young graduate in civil engineering of the Rensselaer Polytechnic Institute. It is not necessary to say that the shoulders sustained the load with eminent success. The labor and responsibility was not small for a young engineer or for any engineer in the world. Mr. Gronau, in his account of the first trip of the Ferris wheel, at which it appears that Mr. Ferris was not present, quite naively says : "Much credit is due Mr. Ferris for valuable suggestions offered in the designing of the turning-gear and machinery, for obtaining the concession from the World's Fair management, and for successfully managing the financial end of the wheel."

And yet it remains to be said, and it is for every inventor to note, that the wheel would not have existed but for Mr. Ferris, while Mr. Gronau's work might have been done by somebody else.

The ideal inventor is a well-informed and well-equipped man all around. I have known some inventors who have had the pushing business faculty in excess ; and who were over-balanced and top-heavy in that direction. Some of them have pushed things into prominence and notoriety that ought to have been pushed into the ground, and that eventually got there. Visionary and loud-talking inventors, some of them honest enough, some of them not honest enough, often entrap and victimize confiding capitalists, and the whole race of inventors is exposed to suspicion and rebuff in consequence. There are many inventions to be developed, not necessarily the most difficult ones mechanically, that are too big to be handled by a man without capital. The capitalist who has been burnt once or twice will not risk getting scorched again, and so the honest inventor may not get the help that he deserves, the public may not get the improved service that they deserve, the capitalist may not get the profitable investment that he deserves ; the blighting inventor that has gone before has turned the whole blooming field into a desert where no man gets his deserts.

Just now the Metropolitan Traction Company is offering a reward of $50,000 for an improved and acceptable means of street-car propulsion. Of course the reward offered is liberal, but it is still very small as compared with the standing offer that exists in the circumstances of the case. There are possibly millions in it, as every intelligent man knows, but the offer of ready cash will act as a stimulus and will spread wide as an advertisement. But it is not every high-mettled inventor, or even probably the ablest and most deserving one, who can build street-cars and the whole system of propelling machinery involved in the experiment and the successful demonstration, and if he cannot secure the coöperation and support of men of means he may invent until doomsday and none be the wiser or better.

Say that the inventor is confident that he can propel street-cars successfully by compressed air, better and more cheaply than by any other means (and the writer hereof has the fullest faith in that direction), and say that, inspired by his belief, he solicits the coöperation of the capitalist. He finds the man of money fully armed to repel him and a ready weapon in his hand. Your capitalist has no mechanical knowledge, and cannot judge by that means of the schemes that are presented for his consideration ; but he has a quick and unfailing memory for undertakings that have failed, and a word can recall a bitter experience. You talk of compressed air. Why there was a pneumatic street-railway company that only a year or two ago made a big splurge and raked in a pile of money—at one time, I am credibly informed, they had three hundred thousand dollars in cash in their hands—and they ended with a shameful and disgraceful fizzle. Though that so-called "pneumatic" system was pneumatic only in name all who had any stock in it have probably had all the compressed air that they want.

Still success succeeds, and the art of it has not yet perished from the earth. Inventors must fill their minds fully with the idea that the introduction of their invention is a part of the invention, and the means of accomplishing it are as much or more to be studied and sought for than the wheels and levers and toggle-joints. The art of making friends and of inspiring confidence should belong to those who most deserve them and every man should look out keenly for his rights. It is not best that a just man should be just last of all to himself.

THE AMERICAN PRACTICE IN SILVER-LEAD SMELTING.

By Walter Renton Ingalls.

ONE of the most important factors in the great increase in the production of silver in the United States during the past ten years has been the improvement in the silver-lead smelting-works and their processes, which, together with the extension of railways through the Rocky mountains, has made it possible to treat ores that formerly could not be mined at a profit. The advance made in this direction has been so far-reaching in its results that the methods of silver-milling, like amalgamation and lixiviation, which belong distinctively to the metallurgy of silver, have fallen off notably in relative importance, and now more than half the silver turned out in the United States comes from argentiferous lead-ores and those smelted with them. On the other hand, the lead industry has become more interwoven with silver-mining, until, out of the 620,000 metric tons of the baser metal that were produced in the world in 1892, much more than half was derived from silver-bearing ores. In the United States alone the percentage was higher, only about 20 per cent. of the whole product coming from the producers of soft lead in the Mississippi valley.

The silver lead smelting industry in the United States is of comparatively recent origin, the first successful works having been erected in 1867 at Argenta, Montana, where argentiferous galena ores were reduced in small blast-furnaces, each furnace treating from two to five tons of ore per day. Two years later the great silver-lead deposits of Eureka, Nevada, were opened, and furnaces were erected at that place. In 1870 works were established at Salt Lake City, Utah, to treat the ores mined in Bingham and Cottonwood cañons. From these beginnings the American practice of silver-lead smelting has been developed.

The second stage of the industry dates back to the opening of the great bodies of lead carbonate ore at Leadville, Colorado, in 1878, which was followed immediately by the erection of smelting-works at that place, where in 1880 there were thirteen plants in operation (three more being out of blast), which produced 36,000 tons of lead, or nearly 35 per cent. of all that was turned out in the United States in that year. The Leadville works of this time were much superior to those of Eureka and Salt Lake City of ten years previous, a better type of furnace having been introduced and the methods of smelting having been improved; but both the cost of smelting and the losses in metal were still high, and the defects of these works in comparison with the model plants of the present day would be apparent even to the layman.

A noteworthy feature of the silver-lead smelting industry of the United States during the first fifteen years of its history was the multiplication of small plants in the immediate vicinity of important mines. Few of these remained long in operation, owing to exhaustion of the mines near which they were located, or inability to meet the competition of the larger and more economical plants that were built subsequently; and the policy of erecting works at isolated points, or for treating ores of individual mines, is now recognized to be unwise. The ruins of such works that are to be found scattered through the Rocky mountains are monuments to one of the steps in advance in the practice of lead-smelting in the United States.

About ten years ago lead-smelting works were established at Denver and Pueblo, in Colorado, at the foot of the Front Range of the Rocky mountains, and with the growth of these began the third and final period in the development of the industry in the United States. These works were so located that they could command the ores from many districts through the branches of the railway systems at whose centers they were built, and they were thus able to obtain better and more profitable mixtures for smelting than the isolated works in the mountains, which were dependent upon single groups of mines; they had the advantages, moreover, of cheaper labor, cheaper fuel and fluxes, cheaper supplies, and cheap freights on ore from the railways, which were interested naturally in concentrating the industry at points giving them the most carriage. The smaller and less favorably situated custom-works could not stand the competition with the new valley smelters, and one by one were forced to close down, with the exception of a few of the Leadville works, those at Salt Lake City, which occupy a more or less central position, and a few others.

The refiners of silver-lead bullion, established chiefly at Omaha, Argentine (Kansas), St. Louis, Chicago, Mansfield (near Pittsburgh), Newark, and San Francisco, also have smelting departments, and some of them, especially the three first mentioned, handle considerable quantities of crude ore. There is a close connection between most of the smelting and refining companies, and the base bullion produced by the former is turned over to the corresponding refining-works ; so the entire treatment from smelting the crude ore to marketing the refined products is done practically by the same concern. Thus all the bullion of the Colorado Smelting Company, of Pueblo, and the Montana Smelting Company, of Great Falls, goes to the National Smelting and Refining Company of Chicago ; that of the American Mining and Smelting Company of Leadville goes to the Chicago and Aurora Smelting and Refining Company of Illinois ; and that of the Mingo Smelting Company of Salt Lake City goes to the Pennsylvania Lead Company at Mansfield. The great Arkansas Valley Works at Leadville and the works at El Paso, Texas, are owned by the Consolidated Kansas City Smelting and Refining Company, which refines all its bullion at Argentine. The Omaha and Grant Smelting and Refining Company and the Pueblo Smelting and Refining Company refine their own bullion at Omaha and Pueblo, respectively, and the Globe Smelting Company has recently established a department at its works in Denver for the same purpose. This affiliation between smelting and refining companies, and the erection of refining-works (formerly grouped on the Atlantic coast, with the exception of one on the Pacific) further west, and at the smelting-works themselves, has been one of the important tendencies of recent years, being the natural sequence of the concentration of the smelting-works. All of the refining companies buy also bullion from outside works, including those of the republic of Mexico, about 13,000 tons of bullion from the latter having been desilverized in the United States in 1892.

In theory the smelting of argentiferous lead-ores is extremely simple, but like most metallurgical processes it is more intricate in practice, wherein extraneous complications enter. There are various methods of smelting, but in the United States only one—roasting and reduction—is in common use. The lead in the ore has first to be oxidized by roasting, if present originally in the form of sulphid (galena), but, if already oxidized (as in the case of the Leadville carbonates), of course no preliminary treatment is necessary. It is then charged into a shaft-furnace together with a certain proportion of limestone, oxid of iron, and fuel, which may be charcoal or coke or a mixture of both. The iron and limestone are added to the ore for the purpose of making a fusible slag. Descending in the furnace the carbonic acid is first driven from the limestone and ore; at a lower zone the charge fuses, the iron and lime combining with the silica of the ore to form a double silicate of iron and lime, while the oxid of lead is reduced by the carbon of the fuel, with the formation of carbonic-acid gas and metallic lead, which collects the gold and silver from the ore and trickles down into the bottom of the furnace, which is called the crucible. The molten slag, being much lighter than the lead, floats on top of it, and is separated by tapping from the furnace at a higher level, the method varying in detail in different types of furnaces.

This is the general principle of the roast-reduction process of lead-smelting, but in practice there are important modifications. Thus part of the lead ore is sometimes fused on a reverberatory hearth previous to smelting in the blast furnace, whereby the lead is converted into silicate, in which form it is charged instead of oxid. Furthermore, it is not economical to oxidize all the sulphid ore, galena, and pyrite, and the furnace charge always contains sulphur. Then there are other metals in the ores, such as copper, arsenic, and zinc, and earthy materials, such as magnesia, baryta, and alumina, which have to be disposed of, and the proportions of iron, lime, and silica in the smelting mixture have to be adjusted so as to effect this. The sulphid and silicate of lead are decomposed by iron with the precipitation of metallic lead. The bisulphids of iron and copper are reduced by iron to monosulphids, forming a matte, so-called. The arsenic also combines with iron as arsenid of iron or speiss. The matte and speiss, both of which carry gold and silver, are heavier than the slag and lighter than the bullion, sinking consequently to a level in the crucible between the two. They are usually drawn off with the slag, however, and separated from it outside of the furnace, after which they are subjected to further treatment (roasting and resmelting) for the recovery of their metallic contents. The earthy oxids, like alumina, baryta, and magnesia, which commonly occur in lead ores, are taken up into the slag as silicates. Zinc, which is the foreign element most dreaded by the lead-smelter, is disposed of in part in the same manner, but in part it is driven off by volatilization. In whatever way it is gotten rid of, however, it leads to increased cost in smelting, wherefore it is customary to make a higher charge for smelting zinc-bearing ores according to the excess in zinc over a certain limit, which may be, for instance, 7 per cent.

THE OMAHA AND GRANT SMELTING AND REFINING COMPANY'S WORKS, DENVER.

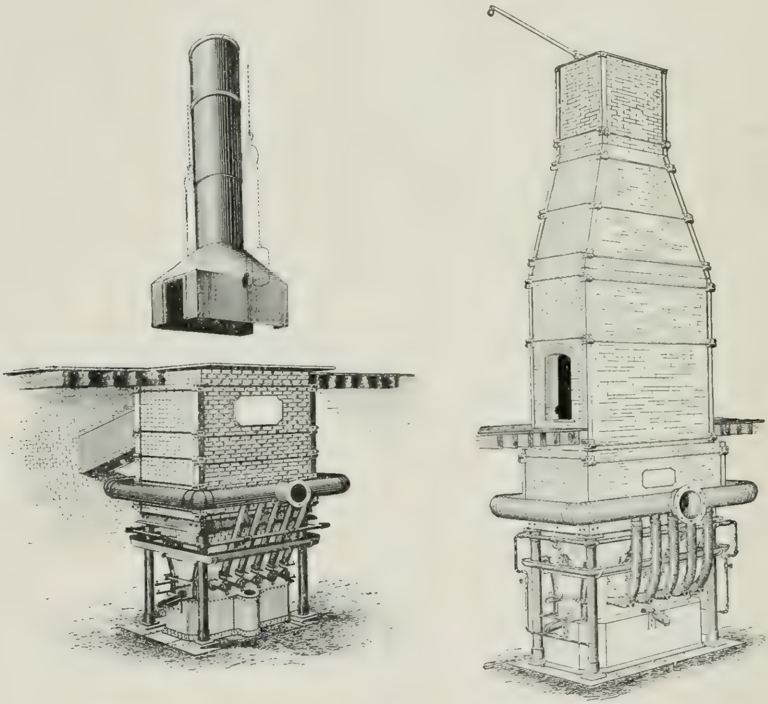
The method of calculating furnace-charges, which is the duty of the metallurgist or superintendent of the works, is too complicated to be explained here in detail, but its principle, which is simple, may be indicated. The smelter buys ores from many mines in lots varying from a few hundred pounds to 100 tons, or more, low grade ore being shipped usually in larger lots than high grade ore. On receipt at the smelting-works the ore is sampled and assayed for gold, silver, and lead, and the settlement with the miner is made on these results. The sample is also analyzed to determine its contents in iron, alumina, manganese, zinc, sulphur, silica, and other elements; in the case of sulphid ores a sample is taken after roasting and analyzed in the same manner.

Analyses are made also of iron, flux, limestone, and fuel. Having arrived at the composition of his material, the metallurgist calculates the proportion of each required to make the proper mixture for the furnace charge. There must be sufficient iron and lime to combine with the silica of the ore in making a slag of desired composition. The ore itself will contain some iron, and perhaps some lime. What more may be needed must be obtained by adding iron, flux, and limestone. Iron must also be allowed for combination with the sulphur and arsenic in the ore. Lead is non-fluxing, but plays an all-important part in the furnace as the collecting agent for the precious metals, for which purpose it must be present in a certain proportion; hence the ores used in making the mixture must be selected so as to give the charge the proper amount of lead. The silver and gold contents of the ore must be considered also, in order to make bullion of an economical grade. The composition of the charge having been determined, the proper proportion of each kind of ore is wheeled to a great bin, where it is made up into a bed, amounting to a thousand tons or more, which is drawn upon for the furnaces as needed, the proportion of limestone and fuel being weighed out and mixed with the charge on feeding.

Of course the ideas of metallurgists as to the best slags and other details vary, though within narrow limits. A very general type of slag in the Rocky mountains is a singulo-silicate, so-called, with 30 per cent. silica, 40 per cent. ferrous oxid, and 20 per cent. lime. The specific gravity of the slag should not exceed 3.6, in order to have a good separation from the matte; so, although the fluidity of the slag increases with the percentage of iron, the latter cannot exceed a certain limit without danger of loss of silver and

SLAG-DUMP OF THE OMAHA AND GRANT SMELTING AND REFINING COMPANY'S WORKS, DENVER.

lead through its higher specific gravity. The lead in the charge should amount to 12 per cent., although within the past two or three years smelters who used to think they should have 15 per cent. have been obliged to run as low as $8\frac{1}{2}$ per cent., owing to the scarcity and increased cost of lead-ore. The tenor of the charge in precious metals should be such as to make bullion with about 300 ounces of silver and one ounce of gold per ton. A good slag should not, then, carry more than $\frac{8}{10}$ ounce silver per ton, and $\frac{3}{4}$ per cent. lead.



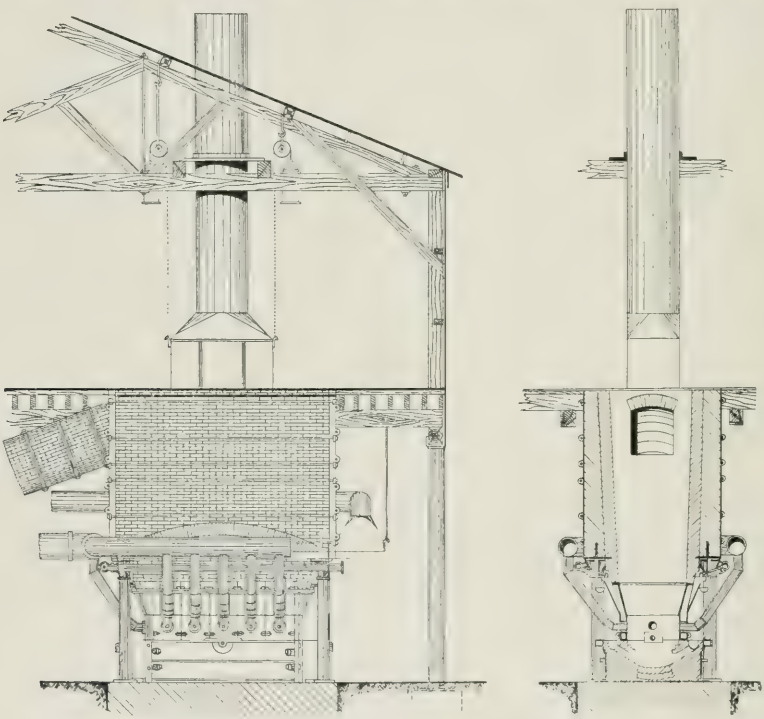
COMMON TYPES OF LEAD-SMELTING FURNACES.

The losses in silver-lead smelting occur in various ways, the most important being in the slag, which, however poor, carries away a large amount of the valuable metals, owing to its great volume. The loss in slag is increased in smelting charges high in zinc, or low in lead, and of course also by irregularities in the running of the furnace. A certain amount of lead and silver is lost, moreover, by volatilization in the form of dust, especially with zinky ores, although a part of this is condensed and collected as

THE GLOBE SMELTING COMPANY'S WORKS, DENVER.

fume and dust in a long series of flues or chambers and subsequently resmelted.

The losses in smelting are taken into consideration, as a matter of course, in buying the ores. Thus only 95 per cent. of the silver is paid for, while the gold brings $19 or even $20 per ounce. The lead is bought on fire assay, which is smelting in miniature and gives results analogous to those of the blast-furnace, but a sufficient discount is made in the rate of payment, based on the New York quotations for refined lead, to give the smelter a safe margin for



A MODERN AMERICAN LEAD-SMELTING FURNACE.

refining and freight to the seaboard. The smelter looks for his profit in the charge for smelting, which varies according to the character of the ore.

The furnaces universally used in the Rocky mountains for lead-smelting are rectangular shafts of fire-brick supported on iron columns which rest on a solid foundation, with a tapering bosh of hollow iron-castings (water-jackets) standing on a hearth of refractory material. Inside the hearth there is a crucible, forming the bottom of the furnace, connected by a siphon-tap with an external lead-well, into which the molten bullion drains and from which it is cast into bars. The slag and matte are drawn off from the front of the furnace, through a tap-hole, into large pots, where the matte settles while the slag overflows into smaller pots on wheels, in which it is carried to the waste-dump. A series of tuyères enter the furnace at ends and sides, passing through the water jackets and protruding slightly into the bosh. The blast for smelting is thus distributed from a large pipe surrounding the furnace, which is connected with the main-pipe from the blowing-engines. From the top of the furnace above the charging door, the fumes are carried through a large pipe called the "down-comer" or "down-take" to the flue-dust chambers ; or the furnace may be quite open at the top, level with the charging floor, in which case the fumes go off through a down-take immediately under the feed floor. The latter style of furnace is the more modern and generally approved.

The modern American lead furnace is from 30 to 42 inches wide, and 86 to 120 inches long at the tuyères. The distance from the bottom of the crucible to the tuyères is 30 inches, and from the tuyères to the charging floor it is 12 to 18 feet, the height depending upon the strength of the blast. As to the latter, some metallurgists advocate a blast $\frac{3}{4}$ to 1 inch pressure of mercury, and others 2 to $2\frac{1}{2}$ inches.

The history of argentiferous lead-smelting in the United States since its inception at Argenta and Eureka has been a record of steady improvement, until at the present time the art has been brought to a higher degree of perfection than exists elsewhere in the world. The first furnaces built, either of the Pilz (round) or Raschette (rectangular) type, were of very faulty construction, and were capable of only a brief campaign, partly on account of the errors in their design and partly owing to the fact that good fire-brick was unobtainable. Charcoal, of inferior quality, was the only kind of fuel used. There were few skilled metallurgists, and even their knowledge of scientific furnace-work was vague, smelting being carried on chiefly by rule-of-thumb methods. Under these conditions it is not surprising that the cost of smelting and losses in slags were high. In Eureka, in the early days, it cost $20 to reduce a ton of ore, and losses of 40 per cent. of the lead and 30 per cent. of the silver are reported.

The first great improvement in the art was the introduction of the siphon-tap by Albert Arents, which revolutionized the method of discharging products from the furnaces. This was followed in 1876 by the investigations of Anton Eilers, now at the head of one of the largest smelting companies in the United States, on the subject of lead-slags, which was continued by Hahn, Iles, and other metallurgists. Smelters then began to calculate their charges with something like accuracy, and the furnace-running was vastly improved. About the same time came the general introduction of water-jackets, which had been invented some years previously, replacing fire-brick at the smelting zone of the furnace and increasing its life. The construction, size, and form of the furnace had also been improved in other respects during this time, so that the length of campaign was extended and the cost of smelting was reduced. These improvements had all been made before smelting assumed important proportions at Leadville, Colorado, but the work at that place, notwithstanding the easily-reduced lead carbonate ore which its mines were then producing, was very far below the present standard. The cost of smelting in 1880 at Leadville averaged $15.25 per ton, and treatment charges on ore $22 per ton. The average grade of the ore smelted was 69.5 ounces per ton silver and 22½ per cent. lead, about 96 per cent. of the former and 88 per cent. of the latter being saved.

Since the rise of the valley smelters, developments in the lead-smelting industry have been rapid and important. The concentration of works into a few large plants and the handling of larger quantities of ore in each have reduced general expenses ; labor-saving devices have been introduced for handling ore, slag, matte, and bullion ; furnace-work has been brought to a higher degree of perfection than exists in Germany, where many of our best metallurgists were trained ; and the furnaces themselves have been improved vastly in construction and size. Where furnaces 24 inches square at the tuyères, smelting eight or nine tons of ore per twenty-four hours, were used in Eureka twenty years ago, we now have furnaces 120 inches long and 42 inches wide, smelting 80 tons. Instead of losses of 40 per cent. in lead and 30 per cent. in silver, as much as 94 per cent. of the lead is recovered, and it is bad work indeed if 95 per cent. of the silver is not saved—and this with charges running only 9 or 10 per cent. in lead against 40 to 48 per cent. in Eureka. Instead of a cost of $20 per ton for smelting, we have an average in Denver of only $4 50 per ton, for a neutral ore (not including roasting, which costs less than $2 per ton).

The old type of round furnaces, still used almost entirely in Germany, has nearly disappeared in the United States, having been replaced by the modern rectangular furnace, itself the successor of the Raschette. This change has come about because the smelting capacity of a furnace is limited by the distance between the tuyères, which it is agreed should not exceed 42 inches, wherefore a rectangular furnace can be built, obviously, with greater capacity than a round furnace.

Important changes have occurred in the past five years in the character of ores treated. The easily smelted carbonate ores of Leadville have been gradually exhausted, and smelters are now obliged to look for their lead in the sulphid ores of Bingham and the Cœur d'Alene, which require, more or less, a preliminary roasting. The quantity of iron sulphid ores and concentrates in the market also has increased, and this class of ore is bought freely by the smelters, with whom it replaces a certain amount of oxid of iron flux, which has to be brought chiefly from Leadville, on unprofitable terms. Now all the large smelting works are equipped with roasting-furnaces, where formerly they had none, and mechanical furnaces, like the O'Hara and Pearce, are being introduced in place of the old form of reverberatory furnaces; sulphid ores are now the common, and oxid ores the rare, class of material which come to market.

At the present time we cannot see great improvements that can be made in our practice of lead-smelting. The general arrangement of the works is good, and the mechanical devices for handling products seem to be complete. The construction of the furnaces does not seem likely to undergo radical changes unless it is possible, as Professor H. O. Hofman suggests, to substitute some suitable refractory material, such as coke-brick, for the water-jackets, which abstract a good deal of heat. The present state of furnace metallurgy, also, leaves little to be looked for, in these days when fierce competition has forced every man to do his best. Still it can never be said that perfection has been reached, and the future may bring new and important developments, but it may be confidently asserted that the changes in the next ten years will not be so revolutionary as in the last.

THE TEHUANTEPEC ISTHMUS RAILWAY.

By Señor Don Matias Romero,

The Mexican Minister at Washington.

MY desire to comply with the request of the editor to write an article on the Tehuantepec railway, now nearing completion, has determined me to prepare a brief sketch on that subject, though it must necessarily be incomplete. There is not at my disposal sufficient time to collect all the facts of importance bearing upon this road, and perhaps in some instances there may be inaccuracies, as my principal guide in preparing the article has been my personal recollection, which may occasionally fail.

In writing these lines I am guided by a spirit of neither jealousy nor hostility towards the Nicaragua canal. I am persuaded that the canal offering the best conditions will finally be built, and, therefore, that any reasoning tending to disregard this circumstance is idle. If the Nicaragua canal offers the best conditions it will be the first to be built, no matter what reasons or objections may be presented in opposition to it.

I believe that while the Nicaragua canal would offer more facilities than one across Tehuantepec, it would be easier to construct across the latter isthmus a ship-railway, and that the opening of both routes, far from conflicting with each other, would be favorable to the commerce of the world as furnishing two different ways, each with especial advantages for crossing the American continent. Not having myself any pecuniary interest in these schemes, I see them from a higher standpoint, considering only their usefulness to the whole world. I also believe that neither of these works will obtain any pecuniary assistance from the United States, because, in the present temper of the people of that country, no money will be expended in any work of public improvement outside of its own limits.

Great importance has always been attributed in Mexico to the subject of interoceanic communication through Tehuantepec. As far back as the time when Hernando Cortes conquered Mexico and passed through Tehuantepec in his expedition to Honduras, he tried to find a natural pass, like the Straits of Magellan, connecting the Atlantic with the Pacific. Cortes then personally examined the isthmus of Tehuantepec, hoping to find that passage. Recognizing the important geographical advantages of the isthmus, he believed confidently that the time would come when a route would be established there between the two oceans. The railroad now being built on the isthmus passes through the lands which, on his application, were donated to him by the emperor, Charles V., and which are now divided into three estates called the Haciendas Marquesanas, because Cortes had been made by the emperor Marquis of the Valley. During the three centuries of Spanish domination this project was in abeyance, because the policy of the metropolis was opposed to all communication of the colonies with the outside world, and the opening of an interoceanic channel was directly contrary to that policy.

Notwithstanding that fact,—but possibly in pursuance of that policy, either to find out whether there was a natural passage between the two oceans, with the purpose of closing it, or, if there was not such a natural channel, not to open it, or perhaps desiring a canal for the exclusive benefit of its navy,—the Spanish government caused serious studies to be made with a view to finding a natural passage or to find out whether one was practicable to connect the Atlantic and the Pacific oceans through the American isthmus. Under Philip II. in the sixteenth, and Charles III. in the eighteenth, centuries, careful surveys were made which were remarkable, taking into account the state of science at that time. A complete survey of the Coatzacoalcos river was made in 1610, which, together with a map of that river, was published in the June (1882) number of the *Bulletin of the Geographical Society of Madrid.* The voyage of Baron Humboldt to America, at the beginning of this century, again awakened great interest in this enterprise, as was exhibited by the action of the Spanish Cortes after the Napoleonic wars.

When the independence of Mexico was accomplished the first Mexican congress made, by decree of October 14, 1823, an independent province of the isthmus of Tehuantepec, which then, as at present, comprised parts of the States of Oaxaca and Vera Cruz. The Mexican congress elected to frame the constitution of October 4, 1824, passed a law on November 4, 1824, providing that the executive should call for proposals for the opening of a route across the isthmus of Tehuantepec, and requesting the executive to collect information to provide for the building of a canal.

In my opinion the advantages to result to Mexico from the interoceanic communication had been overestimated, since it was believed that the opening of a Tehuantepec route would make Mexico the center of the commerce and navigation of the world. Without denying that such communication is bound to produce results favorable to Mexico, especially in developing commerce and industry on her coasts near the isthmus, I believe nevertheless that such expectations were very much exaggerated, and my belief is based on what has happened with the railway across the isthmus of Panama, which has kept open for several years communication between the two oceans. In my judgment the Central American States, in whose ports ply the steamers running between San Francisco and Panama, have been more benefited by that road than Colombia, or even the State of Panama, since they have developed their agricultural production and a prosperous traffic to their great advantage, giving value to their lands, work to their people, and a remunerative result to their enterprises, while no marked advantage has accrued to Colombia or Panama. We have seen the same experience in Egypt with the Suez canal.

The protracted bloody struggle sustained by Mexico in order to shake off colonial principles and church rule, and to follow the pathway of progress, precluded during thirty years any effort in the direction of interoceanic communication. However, as soon as there was a respite in the civil struggle, the project was taken up again. On March 1, 1842, General Don Antonio Lopez de Santa Anna, at that time dictator of Mexico, granted a charter to Don José Garay, to open communication across the isthmus of Tehuantepec, by water as far as practicable and for the rest of the way by rail, beginning the work by a survey of the land and location of the road—which was to be done within eight months from the date of the contract—and fixing a time for the completion of the work. Señor Garay entrusted that work to Señor Don Gaetano Moro, an able Italian engineer, who accomplished it very satisfactorily, this being the first scientific survey of the projected road after Mexico achieved its independence.

The decree of March 1, 1842, which was the first concession made to Garay, provided for the opening of a road through Tehuantepec and entrusted the building of the same to Don José de Garay. That concession was enlarged by a new grant of land, by a decree of February 9, 1843. Another decree provided for the establishment of a prison in Tehuantepec with 300 convicts to help in the construction of the road, and still another extended the term specified for the beginning of the work. The time expired on

June 30, 1845, and that ended the Garay grant, for non-compliance with its provisions, although he applied to congress for a new extension of the term of the concession, which was granted by the house of representatives in December, 1845, but never was voted upon in the senate. But on November 5, 1846, the president of Mexico, acting under extraordinary powers, issued a decree ratifying all previous concessions made to Garay, enlarged the land-grants, and extended for two years from the date of that decree the term for beginning the work.

Notwithstanding all these privileges granted to Garay by the Mexican government, he could not even begin the work under the time fixed, because he could not command the capital necessary. During the progress of our war with the United States, in 1846-47, Señor Garay sold his charter to Messrs. Manning and Mackintosh and John Schneider of London, who, after the war, sold it to a New York company headed by Mr. Peter A. Hargous, but the Mexican government contended that Garay's charter had been forfeited for want of compliance with its conditions, and that all transfers made by him were null and void, not only on that account, but also because the permission of the government to transfer the grant had not been obtained. At the end of that war, by the treaty of Guadalupe Hidalgo of February 2, 1848, by which the United States acquired an extensive coast on the Pacific ocean, it became necessary for that country to look for a short way of communication between its Atlantic and Pacific coasts. Naturally it was thought that Tehuantepec offered the greatest advantages, although the United States, having foreseen that need, negotiated a treaty with New Granada, signed in Bogota Decembei 12, 1846, in which passage across the isthmus of Panama was guaranteed to them, with other very liberal concessions. For the same reason the United States made great efforts to obtain from the Mexican government a charter similar to the one they had obtained from New Granada, which they asked during the progress of the negotiations preceding the treaty of peace; but the Mexican government, fearing, not without reason, a repetition in Tehuantepec of what had just happened in Texas, did not deem it advisable to make the concession for building the road to a company of citizens of the United States, and answered that, as a grant was already in the hands of the Garay company, the government had no right to dispose of the same.

As a consequence of this answer given by the Mexican plenipotentiaries who signed the treaty of Guadalupe Hidalgo, the parties interested in building the Tehuantepec railroad obtained the cession of the charter from Messrs. Manning and Mackintosh, who, in their turn, considering themselves the successors of Mr. Garay, sold their charter to a United States company and asked a guarantee of the United States government to develop said concession.

This government requested Mexico to make a treaty for that purpose, and, notwithstanding the reluctance of Mexico on this point, at the request of the United States government the Mexican plenipotentiary signed on June 23, 1850, a treaty with Mr. Robert P. Letcher, the minister from this country at the city of Mexico, by which both governments guaranteed the neutrality of the isthmus, under certain conditions that were considered sufficient to assure the autonomy and independence of Mexico, but that treaty was rejected by the United States senate, and the United States government asked for a modification of the same, which request resulted in another treaty, signed January 25, 1851, and rejected in its turn by the Mexican senate.

The principal cause of the rejection of those treaties was that the government of the United States contended that they guaranteed the Garay charter, which had fallen into the hands of United States citizens, while the Mexican government, far from accepting that view of the case, declared the said concession forfeited, and considered that it would be extremely dangerous for Mexican interests should that road be built by citizens of the United States.

The feeling of distrust against the United States which prevailed in Mexico immediately after the war of 1846 and 1847 was strengthened by reason of some filibustering invasions of the border states of Mexico, which occurred about that time, and which the United States government could not prevent. As the people of Mexico did not understand well the laws of the United States, the extent of personal guarantees enjoyed here, and the feeble action of the federal government in the States, it was not believed that this government had no power to prevent such invasions.

It is very satisfactory to notice the change in the relations between Mexico and the United States since 1851. The Mexican government at that period not only refused to grant a concession to citizens of the United States, but considered it dangerous for engineers from that country to finish the survey which they were making of the isthmus of Tehuantepec.

Now, however, almost all the railway concessions given by the Mexican government—and their number is considerable—have been made to citizens of the United States. The principal railways in Mexico, with only two exceptions—those running from Vera Cruz to the city of Mexico—have been built by companies organized in the United States. The idea of permitting the passage of troops from the United States into Mexican territory in pursuit of hostile Indians was then considered as inacceptable; indeed, according to the statement of Mr. Robert P. Letcher, the American minister, made to Señor Don Fernando Ramirez, the then minister of foreign affairs of the Mexican government, United States soldiers were then more objectionable in Mexico than hostile Indians. Since then, however, that permission has been freely granted and with satisfactory results. This shows that the situation of distrust and even unfriendliness resulting from the war of 1846–47 has given place now to one of mutual friendship and cordiality, as a consequence principally of the change in the political tendencies of the parties in the United States which do not seek now, since the abolition of slavery, to annex Mexican territory.

In view of the determination of the Mexican government not to recognize the charter for the building of the road which had come to the hands of a company of citizens of the United States, the parties interested in the transit applied to the government of New Granada, and received from the latter a liberal concession. The construction of the Panama road was begun on April 18, 1850, and ended on January 20, 1855. The building of that road made unnecessary, for the time being, the construction of the Tehuantepec road, and this circumstance, in my opinion, more than anything else, has been in the way of the building of the Tehuantepec road.

The agitation produced by the treaties negotiated with the United States about Tehuantepec and the efforts of the parties who had succeeded in the Garay grant to have it recognized by Mexico gave rise to a long and bitter discussion, with the result that the Mexican congress, on May 22, 1851, declared forfeited the charter granted to Don José Garay on the ground that he had not fulfilled its conditions.

But the Mexican congress, awake to the necessity of opening a means of communication, passed a decree on May 14, 1852, requesting the executive to promote the organization of a company to undertake the building of the Tehuantepec road, on the basis therein set forth. Pursuant to that decree the executive branch of the government published, on July 29 of the same year, a notice inviting proposals for the building of that road, and, after considering those that were presented, a contract was signed with Mr. A. G. Slow and others, by which it was agreed that a year after the signing of the contract a plank road should be commenced to be ended three years afterwards, and then succeeded by a railroad, which should be completed within the following four years.

The same decree of May 14, 1852, provided that negotiations with friendly powers would be opened, with a view to arranging treaties which should recognize the neutrality of the passage through the isthmus, in case of war; and by virtue of that provision a treaty was signed at the city of Mexico on March 21, 1853, between the Mexican plenipotentiaries and the United States minister, in which permission was granted to the United States government to guarantee with armed force the neutrality of the isthmus, when requested by the Mexican government, and granting it besides the free passage of their troops from one coast to the other. In the treaty especial guarantees were joined to the contract with Mr. A. G. Slow and company; but, for the reasons already pointed out, that treaty was rejected by the Mexican congress, and in consequence of this fact, and on account of the Panama road having been commenced, the Slow company could not fulfil their contract.

On September 7, 1857, the administration of General Comonfort, acting under extraordinary powers, granted to the Louisiana Tehuantepec Company, organized in New Orleans on July 30 preceding, a charter for the construction of the Tehuantepec route, making use of the Coatzacoalcos river as far as it could be made navigable, the rest of the distance to be covered by rail. Work was to begin within eighteen months after the date of the decree, the railway was to be built at the rate of ten Mexican leagues (about twenty-six miles) per year, and a carriage-road was to be opened at the beginning. The latter was opened, in part, and in this way a stage-coach line was established in connection with ships running between New Orleans and Minatitlan and between Ventosa and San Francisco, except that passengers had to travel a short distance by horseback. The company agreed to pay Francisco P. Falconet $600,000 and interest, which was deposited by the Slow company with the Mexican government in accordance with Article IV of their contract, and therefore the Louisiana company was in fact the successor of the Slow company.

After several additional concessions had been made, a decree issued by President Juarez on October 15, 1866, declared the forfeiture of the concession made to the Louisiana Tehuantepec Company, owing to the non-fulfillment of its obligations, and granted the same to the Isthmus of Tehuantepec Company, which failed also to fulfill its obligations, after which the charter was forfeited by a decree of August 16, 1867.

The war of reform on one hand, which lasted from 1857 to 1866, and the French intervention on the other, from 1861 to 1867, as well as the bad financial situation of the world, had prevented the work, notwithstanding the several concessions successively made by the Mexican government; but it was believed that with peace restored to Mexico, the principal drawbacks had disappeared, and, on October 6, 1867, a concession was granted—also by virtue of extraordinary powers vested by congress in the president—to Emile La Sere, a native of New Orleans, or to a company that he might organize. This concession was modified by an act of the Mexican congress under date of January 2, 1869, considerably amplifying the privileges granted to Mr. La Sere or his company, and extending the terms for the completion of the work.

Another act of the Mexican congress, under date of December 20, 1870, renewed and extended the terms of that concession, though the name of Emile La Sere was then omitted. The act passed by the Mexican congress on May 22, 1872, renewed the concessions of 1869 and 1870, and provided that the time for building the road should be counted from January 2, 1872.

The Mexican congress, by an act of June 2, 1879, gave a charter to Edward Learned, a citizen of the United States, or the company that he might organize, to build the Tehuantepec road within three years and four months from the date of the charter, and offered a subsidy of $7500 for each kilometer of road built by the company and actual land opened. Mr. Learned organized a company in New York which held the grant for several years and built in a provisional way a few miles of road from the mouth of the Coatzacoalcos river towards the south.

After long experience in ineffectual efforts had shown that it was not possible to secure this road even under the liberal concessions made by the Mexican government, it was suggested that the government should undertake the work on its own account. Congress, therefore, authorized the executive, on May 30, 1882, on account of the State, to build the Tehuantepec railway or to contract for its construction with a company.

By virtue of this authorization the Mexican government signed, on October 15, 1888, a contract for the construction of the road with Edward McMurdo, the representative of Salvador Malo, authorizing a loan of £2,700,000 for the expenses of the same, which was raised at London, Berlin, and Amsterdam by the sale of 5-per-cent. bonds at about 70 per cent. This contract was approved by an act of the Mexican congress of December 19, 1888, and was modified by another contract signed on October 15, 1889, also subsequently approved by congress.

To carry out this purpose it was necessary first to terminate the contract still pending with the Learned company. This company agreed to give up the contract, receiving a compensation for expense and damages of $1,500,000 in United States gold, which I paid in New York on behalf of the Mexican government.

As the proceeds of the loan of £2,700,000 were not sufficient to finish the road, part of another loan of £3,000,000, recently contracted at the city of Mexico, has been applied to that work. On December 6, 1893, a contract was signed at that city for the construction of the fifty-nine kilometers of road unbuilt, and it is provided in the same that the line shall be finished on September 6 of this year, with an additional expense of over $1,000,000.

This account would not be complete if I failed to mention that the distinguished engineer, James B Eads, conceived a project for building a railway capable of transporting ships from one ocean to the other, across the isthmus of Tehuantepec; and for that purpose he made on April 26, 1881, a contract with the Mexican government, which was ratified by the act of the federal congress on May 28 of that year, and that charter was modified and amplified by another contract signed at the city of Mexico with the representative of Captain Eads on May 2, 1885, which was also approved with certain alterations by the Mexican congress on December 15, 1885. In the first of those contracts it was stipulated that the work would be finished within twelve years from May 6, 1881, and that term was extended two years by the second contract. The Mexican government promised to pay the company as a guarantee $18,750,000 at the rate of $1,250,000 each year, to be eventually refunded if the profits of the railway should exceed $3,750,000 a year, and in that case the sixth of that excess would be applied to the payment of the subsidy. The company was authorized to build a canal from Laguna Superior to the Pacific ocean, and it was further offered 168 square kilometers of land for every foot in depth of said canal. It was also offered 4200 square kilometers of land if it should deepen the Coatzacoalcos 25 feet.

Unfortunately, the extraordinary character of the project and the other difficulties to which I have alluded have not permitted the construction of this great work, but as a similar road is on the point of being completed on the isthmus of Chignecto, which connects the peninsula of Nova Scotia with the mainland in Canada, and will show the practicability of the work, it is likely that this fact will pave the way to the construction of a similar railway across the isthmus of Tehuantepec. The Chignecto ship-railway, which will connect the navigation of the Bay of Fundy with the Gulf Saint Lawrence, is 17 miles in length and capable of carrying ships weighing 2000 tons. About three-fourths have already been built.

All the grants above mentioned have led to the making of surveys of Tehuantepec. Besides the one made by Señor Moro, the United States Company in 1850 sent Major J. G. Barnard, U. S. A., as chief of engineers, to make a survey of the Tehuantepec isthmus, and although the condition of affairs which I have tried to sketch compelled the Mexican government to order the suspension of the survey, it had already been finished when Major Barnard was notified to leave the work, and the results were subsequently published.

During the administration of General Grant another and more complete and important survey was made, he wishing to ascertain which of the three isthmuses was the most convenient for the construction of a means of interoceanic communication. He sent a commission of able engineers, which decided in favor of the way through Nicaragua. The concession made to Captain James B. Eads caused a more elaborate survey to be made, not only of the railway, but also of the terminal points.

The Mexican government sent a delegate to present the advantages of Tehuantepec at the International Congress on American Interoceanic Communications convened in 1879, at Paris, at the suggestion of M. Ferdinand de Lesseps, but he could hardly be heard for the reason that the preference was given to the Panama route almost before the meeting of the conference, though without taking into consideration the difficulties to be encountered. As M. de Lesseps was the promoter of the congress, it was composed largely of his friends, and he obtained a vote in favor of Panama of 74 members, while only 14 voted against him and 7 refrained from voting. The Mexican delegate voted against Panama. Those who did not vote represented that the matter had not been sufficiently discussed and that a majority of the members were not competent to decide the difficult technical questions, and among these were Admiral Ammen and Señor Menocal, delegates from the United States; Señor Don Manuel M. de Peralta, delegate from Costa Rica, and now minister from that country to Washington, and Señor Ordonez, delegate from Colombia. M. La Valley, the distinguished French engineer who built the Suez canal, and who was a friend of M. de Lesseps, did not vote for Panama.

After so many efforts resulting in failure, the Tehuantepec road is now practically completed, and Mexico offers the result of all this work of many years to the commercial interests of the world.

The comparative advantages of the Tehuantepec interoceanic route over the Panama route, in reference to geographical and commercial features, are great. Any map showing the two routes will prove in a general way the geographical advantages of the Tehuantepec route in reference to the coastwise commerce of the United States, and, in a measure, its advantages in relation to the business of western Europe. Admiral Schufeldt, U. S. N., in an official report made in 1871, thus forcibly expressed the commercial advantages of Tehuantepec: "Each isthmus rises into importance as it lies nearer to the center of American (United States) commercial interests." Other things being equal, the route which has the greatest advantages will lie nearest to what may be considered the *axial line of the world's commerce*, which may be drawn on the globe between Hongkong and Yokohama on the Asiatic coast across the Pacific ocean, through San Francisco, across the United States to New York, and across the Atlantic to Liverpool or Havre. Tehuantepec, of all the interoceanic routes, lies nearest to this "axial line." In a direct line the distance is 1200 miles between Tehuantepec and Panama, or about as far as from New York to New Orleans.

Examination of a globe will show that the shortest sail or steamer route from eastern Asia to any point on the Pacific coast of the American isthmus passes in close proximity to the shore line of Tehuantepec; in fact, the shortest great circle from Panama to Hongkong will pass through Tehuantepec, east of San Francisco, and nearly up to the Aleutian islands. Even the shortest route from Panama to the Sandwich islands will pass close to Tehuantepec. It will at once be apparent, therefore, that it will require almost a doubling of the above-mentioned distance to cross the isthmus at Panama, particularly for all traffic of the Pacific ocean seeking gulf ports. In a lesser degree the distance by way of Panama to all Atlantic ports of the United States and eastern Europe will be largely increased over the Tehuantepec distance.

DISTANCE IN STATUTE MILES BETWEEN PORTS.

[Compiled at the Hydrographic Office, Bureau of Navigation, United States Navy Department.]

Terminal Points.	Via Tehuantepec Railroad.	Via Nicaragua Canal.	Via Panama Railroad.
New York to San Francisco..........	4925	5651	6107
New York to Puget Sound..	3047	6524	6855
New York to Sitka........	6347	7113	7555
New York to Bering Strait.	7788	8534	9101
New York to Acapulco....	2722	3507	3988
New York to Mazatlan.......	3476	4232	4675
New York to Hongkong.............	11597	12313	12645
New York to Yokohama.......... ...	9984	10626	11211
New York to Melbourne............	11068	11357	11471
New York to Auckland.	9345	9745	9813
New York to Honolulu..............	6566	7390	7705
New York to Callao............. ...	4661	4312	3873
New York to Guayaquil..............	4141	3774	3303
New York to Valparaiso..............	6370	5774	5337
New Orleans to San Francisco.......	3561	4776	5415
New Orleans to Acapulco...........	1454	2631	3296
New Orleans to Mazatlan............	2027	3357	3983
New Orleans to Callao	3393	3436	3181
New Orleans to Valparaiso...........	5040	4899	4644
Liverpool to San Francisco...........	8274	8783	9071
Liverpool to Acapulco................	6076	6639	6952
Liverpool to Mazatlan...............	6714	7364	7640
Liverpool to Auckland	12584	12877	12777
Liverpool to Guayaquil.	7379	6848	6267
Liverpool to Callao..................	7899	7444	6837
Liverpool to Valparaiso..............	9356	8906	8301
Liverpool to Honolulu.......	9805	10522	10670
Liverpool to Yokohama....	13223	13758	14175
Liverpool to Melbourne..............	14113	14499	14435

If a comparison is made between Tehuantepec on sixteen of the main routes of commerce between the east and the west, the total saving by Tehuantepec is over 125,000 miles. It will also be seen that the question of comparative distance also affects to an important degree the entire interior of the United States, particularly the Mississippi valley. It is only a little over 810 miles from the mouth of the Mississippi river to the eastern terminal of the Tehuantepec railroad. The total distance by rail and water from Chicago to the Pacific ocean via Tehuantepec is only 1875 miles.

The *nautical* conditions for sailing vessels are much more favorable at Tehuantepec than at Panama. Navigators always avoid, if possible, the region of calms on both sides of the Panama isthmus. These calms extend well into the Pacific ocean at Panama. Lieutenant Maury and Captain Bent, both acknowledged nautical experts, are my authority for this statement.

This advantage may be considered by some as of little importance on account of what is supposed to be the rapid substitution of steam for sail, but, as far as the United States is concerned, the advantages of good nautical conditions are important, and will be for many years, as their sailing tonnage greatly predominates over steam. From the above statement it is apparent that an interoceanic route established at Tehuantepec will connect, at the best possible location, the eastern and western coasts of the United States and Mexico, and will develop a coastwise business of great magnitude and of vast importance to these two countries if controlled and managed by United States interests.

The *climatic* conditions are more favorable at Tehuantepec. The northeast trade-winds from the United States cross the Gulf of Mexico, making the climate of Tehuantepec healthful. I was born and for many years lived at the city of Oaxaca, the capital of the State to which Tehuantepec belongs, and have been in Tehuantepec, and I can assert by personal knowledge that it has a healthy climate, taking in consideration its latitude and altitude.

General Porfino Diaz, who has been the president of Mexico since 1877, with an interval of four years, is a native of the city of Oaxaca, and he spent two of the most eventful years of his life—1858 and 1859—in Tehuantepec as civil and military governor of that district, and has had great interest in building that road. To his exertion is due the condition in which that work is now nearing completion. It is to be hoped that its results will be beneficial to the commerce of the world, and that will be a compensation for the many efforts, disappointments, and great expense made, suffered, and borne by Mexico in carrying out this great work of public improvement.

After I had written my first draft of this article, fearing that I might have omitted important facts or committed serious inaccuracies, I sent to the proper department of the Mexican government a copy of the same, for its revision and correction. The editor of the Magazine, however, having made arrangements for the publication of the paper at this time, and desiring not to disappoint or inconvenience him, I have consented to let the article go before the public before receiving the data which without doubt has been sent from Mexico If it should seem necessary later, I may write a short statement pointing out any inaccuracies in this article, for publication in the next number of the Magazine. M. R.

ELECTRICITY

Conducted by Franklin L. Pope.

AS long ago as 1880 the late Dr. Charles W. Siemens, in a paper read before the Society of Telegraph Engineers, gave an interesting account of the results of a series of experiments in electro-horticulture, made by him in his conservatories near Tunbridge Wells, England. He found that the exposure of growing plants to the rays of the arc-light had a decided effect in the promotion of their growth, and in the development of chlorophyll in their leaves. It appears also to have been pretty conclusively established by his results that the idea formerly prevalent that plants require a period of rest during a part of each twenty-four hours has no foundation in fact, as the plants experimented upon by Dr. Siemens, although exposed to full sunlight during the day and to the rays of the arc-light during the night, made increased and vigorous progress in consequence. The electric rays, moreover, proved peculiarly efficacious in accelerating the development of flowers and fruit; the flowers were remarkable for the unusual vividness of their coloring, and the fruit both for its beautiful bloom and its fine aroma. Further experiments in this general direction, though upon an entirely different plan, have been made during the past year at the Hatch experiment-station of the Massachusetts Agricultural College. Small plots of ground were planted with common garden vegetables, and a constant current from a voltaic battery was made to pass directly through the mass of earth in which the roots of the plants were embedded. The foliage of the parsnips which had been thus subjected to the action of the electric current showed a growth far more vigorous and rapid than those occupying a non-electrified plot, although planted at the same time, and when harvested seemed to be nearly twice as large; the roots also were much heavier, and, as a whole, the plants showed a marked difference in favor of electric culture. A peculiar effect which was noted, for which no satisfactory explanation has been suggested, was that the plants nearest the negative electrode grew much faster, and ultimately became much larger than those at a greater distance from it. Upon carefully weighing the products of the respective plots it was found that in the electric plot nearly a pound of tops had been produced for every pound of roots, while in the non-electric plot there were 1.43 pounds of roots for each pound of tops. In the total weight of roots and tops the difference in favor of electric culture was found to be as 34 pounds 10 ounces to 24 pounds 3 ounces. Other kinds of vegetables with which similar experiments were made gave results very nearly proportional. If the transmission of electric currents through the earth has an important influence on the growth of plants, as these experiments would seem to demonstrate, the market gardens in the suburban districts of Boston, Brooklyn, and other cities gridironed by electric railways, surely ought to be in an exceptionally flourishing condition.

THE most serious problem that to-day confronts the managers of the telephone systems of the United States is the continual expansion of the service; not so much that due to the augmented number of exchange subscribers, as to the increased use by each individual subscriber of the facilities offered. Ten years ago, for example, the average number of calls and connections made by each subscriber in the larger cities was about six, but at the present time the average has already increased to twelve. It is a fact not generally appreciated that the cost of central-station apparatus and equipment, as well as that of operating the exchanges, increases almost in the ratio of the square of the number of subscribers. This is the principal reason why the telephone companies are compelled to charge their customers so much higher rates in the larger than in the smaller exchanges. A moment's reflection will show that the true criterion of the cost of telephone service to the subscribers is not the yearly rate, but the average cost to each user per conversation or connection made. It certainly does seem inequitable that a person who uses his telephone perhaps not more than three or four times per week should be charged the same yearly rental as one who keeps it in constant use all day and every day, but the fact must not be lost sight of that it is necessary to provide facilities for the most extensive service for each subscriber, whether availed of or not, and that it costs a great deal of money to effect this result. The true solution of this perplexing problem will doubtless be found, in the future, in some plan by which each subscriber will be charged a flat yearly rate sufficient to cover interest on first cost and ordinary cost of maintenance of plant, together with general charges of administration, and in addition to this will be required to pay a fixed charge per connection made or message transmitted. By this plan the proportion between gross receipts and operating expenses will be maintained, and each subscriber will in effect pay for what he gets. This system or something nearly resembling it has been in vogue in some cities, notably Buffalo, for manv years, and appears to have, on the whole, given good satisfaction. Unless some such plan as this is adopted it appears to us that the time must come, and that before many years, when even the apparently excessive rate now charged in New York city will be found to be insufficient to cover the actual cost of performing the service required.

In anticipation of the expiration of the patents on the Bell telephone-receiver, many enterprising manufacturers in various parts of the country had made extensive preparations to offer these instruments for sale in the open market at various prices, ranging from $3 upward. It could have scarcely have been expected that these could have received with unmixed gratification the announcement made by the Bell telephone companies, within a day or two after the date of the expiration of the patents, that instruments of their well-known standard make and finish would be sold freely to all purchasers at the almost nominal price of $1.25 each. The result of this move undoubtedly will be a great popularization of the telephone for purposes of private intercommunication, inasmuch as a complete outfit of telephones, signal-bells, and a connecting line say half a mile in length need not cost, at present prices, more than $30 or so, while the cost of maintenance, other than that of keeping the line in repair, will be practically nothing. The ultimate effect of thus accustoming everybody and his wife and children to the use of the telephone cannot but be to enormously increase the demand for exchange facilities, especially in the provincial cities and towns. The telephone is certainly destined to become a most invaluable convenience to the rural householder throughout the land.

The New York capitalists who have invested more than $3,000,000 in the stupendous power-plant now under construction at Niagara Falls have exhibited very little anxiety to exploit their plans in the public journals, and, as an inevitable consequence, a vast amount of misinformation on the subject has found its way into print. The general plan of the work was accurately described by Dr. Coleman Sellers in an early number of this Magazine, but at that time many of the more important details were yet undetermined. It was ultimately decided that of the 100,000 horse-power provided by the existing tunnel, when utilized to its full capacity, 50,000 should be allotted to manufactories situated in the immediate vicinity, most of which are expected to be of a character requiring power in large blocks—such as paper- and pulp-mills, and electrical smelting-works—

while the remaining 50,000 should be converted into electrical energy and transmitted by wire to points where it could be advantageously utilized in smaller units. The three dynamos now building at Pittsburgh, which are expected to be in place and at work early in the coming summer, are to have a capacity of 15,000 electrical horse-power, most of which will probably be sent to Buffalo, as a power-distributing company which has been formed in that city is said to have contracted for a minimum supply of 10,000 horse-power. Other companies for the same purpose have been formed in a number of the principal cities and towns of central and western New York. The price at which the electric energy will be furnished has not been absolutely fixed, but will probably be something like $12 to $15 per horse-power per year, for the twenty-four hours. Even in the present state of the art it is not improbable that the power from Niagara can be supplied at a rate permitting commercial competition with coal, at any point within a radius of one hundred miles.

It is a fact which is, or at least ought to be, well known to engineers, that the term "horse-power," as signifying a certain rate of doing work, is absolutely meaningless, except as an arbitrary conventional term which has been adopted by common consent. The tradition is that James Watt, by experiments with a good average Clydesdale draft-horse, found that such an animal could do work, day in and day out, at a rate approximating 22,000 pounds raised one foot in one minute, and then, distrusting the results of his own experiments, he arbitrarily raised the value of his horse-power unit to 33,000 foot-pounds. Of late years the distribution of power is obviously falling largely into the domain of electricity, and hence is more and more coming to be commonly spoken of in terms of the accepted electrical units, which, as is well known, are based on the decimal or metric system. Of the electrical unit of rate of work, the watt, 746 go to the horse-power, but any considerable amount of power is more conveniently measured in kilowatts, of 1000 watts each, ordinarily abbreviated as "k. w." Now why should not mechanical as well as electrical engineers agree to drop, once for all, the meaningless term "horse-power," as a relic of the dark ages, and henceforth determine to use the far more convenient as well as more scientifice unit the kilowatt? Fortunately, the relation of the old and new units happens to be such that they may be converted into each other, with sufficient accuracy for most purposes, by a very simple mental calculation, the horse-power being three-quarters, or, in exact terms, 74.6 per cent. of the kilowatt. The time is prophesied when the horse, except as a zoological museum curiosity, will be unknown, but the horse-power has already become, at least among electrical engineers, a useless anachronism.

It is stated in foreign journals that the conduit electric-railway system which has been at work for some years in Budapest has proved so satisfactory in its practical operation that it has now been determined to replace all the horse lines in the city by electric lines operated in the same way. The total length of the extensions proposed will be over forty miles.

One of the manifold possible uses of the telephone, which for some reason has failed hitherto to receive anything like the attention which its importance would seem to warrant, is that of interior service for offices, stores, manufactories, and the like. Within a year or two, however, some very ingenious and effective systems of this character have been devised, which, so far as they have been practically introduced, have given great satisfaction. It seems not in the least unlikely, now that the patents on the essential portion of the apparatus have expired, that the number of instruments required for what may be termed interior intercommunication may, within two or three years, exceed the aggregate number in use in the regular exchanges.

The tendency of the constructors of electric central stations in the principal cities is towards larger and larger units. In the Elm-street station of the Edison

Illuminating Co. of New York a quadruple-expansion engine of 3000 horse-power has recently been set up, which is coupled directly to a pair of dynamos each of 800 kilowatts, or 1350 horse-power capacity. The steam-piping of this plant is constructed to stand a pressure of 225 pounds per square inch.

THE discussion of the relative merits of the cable and electric systems of propulsion for street-railway service is still continued in a desultory way in the technical journals, although the subject would seem by this time to be pretty well threshed out. It now appears to be quite generally admitted that in all cases where the overhead trolley system is permissible, not only the cost of construction, but the cost of maintenance and of operation is much lower for the electric than for the cable system, and this is equally true whether the traffic be heavy or light. The stock objections which are reiterated to the trolley system; the unsightliness of the overhead structure; the interference with the fire-extinguishing service, the increase in insurance rates, are, after all has been said, of almost insignificant importance compared with the great good which it confers upon a great number. It is undoubtedly true that in many localities there is a decided need of the imposition of more restriction upon the reckless speed at which street-cars are sometimes run, and that in thickly populated districts the substitution of a conduit system for the overhead construction should be brought about as soon as practicable. We do not, however, believe that it is true, as stated by a prominent transportation journal, that the conduit system "has purposely been kept in the stage of experiment" by the electrical companies. It is probable that the cost of construction of a thoroughly good conduit system, should one be developed, will be little if any less than that of a cable system, but the former may reasonably be expected to make much the best showing of the two in respect to cost of maintenance and operation. We fully believe, however, that means will yet be found to cut down the consumption of power per car, to at least one-half of what it now is with the best electric systems.

THE annual report of the railroad commissioners of Massachusetts for the year ending June 30, 1893, shows an increase of 214 miles in the aggregate length of street-railways operated by electricity within that commonwealth. The judicious and timely warning of the commisioners against the prevalent craze for gridironing the earth with electric railways, which has been in some degree postponed but by no means permanently dissipated by the financial stringency of the past year, deserves more attention from investors than it is at all likely to receive. Referring to the idea which seems to have taken possession of many minds, that an electric-railway system is necessarily a bonanza of inexhaustible wealth, the commissioners say: "It can and should be said, without hesitation or qualification, that the electric system has not shown or indicated any such margin of profit as to justify the expectation of more than moderate and ordinary returns on money legitimately invested in it. . . . . The absolute cost and expensiveness of the system under the most conservative, able, and honest management, are sufficient to task its earning capacity to the full limit. There is no margin for fictitious or inflated capitalization. It presents no safe or inviting field for speculative enterprise or manipulation, unless it be to the unscrupulous operators of an inside ring who are willing to practice on the credulity of a misinformed public." The commissioners indeed even go so far as to say: "We must conclude, taking everything into the account, that there has thus far been no demonstration of the superior net-earning capacity of the electric as compared with the horse system, but rather the reverse." From their point of view, which is of course based on the detailed returns of receipts and expenditures filed in their office by the various railway companies of the commonwealth, the commissioners are doubtless justified in their conclusion. But, on the other hand, it must not be forgotten that the electric-railway system is even yet largely in an experimental stage. For example, the constant improvements which have been made in the details of motor construction have been such as to render it necessary to replace the earlier types by wholesale, even when but slightly deteriorated by use, simply because the new designs were so much more economical in operation than the old that the use of the latter could no longer be afforded at any price. Then, too, the art of operating electric railways with the utmost attainable economy, though well enough understood by many experts, is one that is learned but slowly by many of the men who have the actual management and handling of the mechanism. The introduction of these minor economies is a process that necessarily takes time, even under the most intelligent and energetic management. We hazard little in making the prediction that within ten years electric railways will be operated at one-half the present expenditure of power and at one-half the present cost of maintenance. But we agree most emphatically with the commissioners in their evident opinion that there is no miraculous power in electricity which will save an electric railway from the too-familiar fate of the steam- or horse-railway, which is confronted with the adverse conditions of injudicious location, inefficient management, and over-capitalization.

THE telephone system of New York city now comprises no less than eight independent exchanges, all equipped with metallic-circuit multiple switch-boards, and furnishing in the aggregate accommodation for 15,000 subscribers. The present number of subscribers in connection with all the exchanges is about 9600. There are 800 private-line stations, and no less than 30,000 miles of underground wire. The average number of conversations per day in the city is between 80,000 and 90,000. Each subscriber uses his telephone on an average sixteen times per day, although in some instances it is used as often as 100 to 200 times per day. About 400 young women are employed as operators in the central offices, 250 of whom are usually on duty at the same time. Each of these operators makes an average of nearly 400 switchboard connections per day. The aggregate working force required to maintain the Metropolitan telephone service comprises about 1000 employés, or about one to every nine subscribers. As the yearly rate paid for the rental of each telephone is $240, it appears that the average cost to the subscriber per conversation is only 4.9 cents. The cost of transmitting the same amount of information by telegraph, at the regular Western Union city rate of about one cent per word, could hardly cost less than ten times as much. The improvements constantly being made in the details of the service, while they do not, and from the nature of things cannot, lessen the annual cost per subscriber, do materially increase the facility of use, and in that way constantly diminish the cost per message, which, as we have elsewhere pointed out, is the only true criterion of the actual cost of telephone facilities.

IT is now announced in the newspapers that the parties who were in charge of the recent experiments illustrating the utilization of electricity for the propulsion of boats upon the Erie canal, design to fit up a boat with electric motors and propellers of the most approved design, which is to be propelled by storage-batteries, and equipped with all kinds of electrical labor-saving devices, and exhibited along the line of the canal as a sort of object-lesson in the uses of electricity. We would suggest that the most appropriate source of energy for charging these storage batteries would be wind, which can usually be obtained at reasonable rates upon the breezy hill tops of the Empire State. Still, we cannot resist the conviction that what is really needed to permanently improve the navigation of the Erie canal is more water, and less rather than more wind.

THE statement is made, apparently by authority, that the trade of one of the principal electrical companies of the United States, for repairs of electrical machinery alone, amounts to nearly $4,000,000 per annum. This allegation, if true, indicates a state of facts, which would seem to call loudly for immediate reform.

AN electric-lighting plant driven by wind-power has for some time been in successful operation in Jersey City. The wind-wheel is 18 feet in diameter, and self-regulating. With a wind-speed of twenty miles per hour it is said to give about 3 horse-power, and the generating machinery comes into action only when this speed has been reached. A small dynamo of a capacity of 35 volts and 35 amperes is employed, which is belted to the wind-wheel, through an intermediate bevel-gear. A storage-battery charged by the dynamo, and fitted with an automatic cut-out, provides current for twenty-four incandescent lamps, distributed about a workshop.

RECENT experiments have been made which are claimed to have demonstrated that rapidly-alternating electric currents, of which telephonic currents are merely a particular case, are much more perfectly transmitted through a conductor composed of two metals of different specific electrical conductivity, than upon one consisting of a single homogeneous metal, and this, in spite of the fact that the conductivity of the latter, for steady currents, may be much the higher of the two. It is also asserted that a much lower insulation resistance is needed to confine the current to the bimetallic than to the monometallic conductor. No satisfactory explanation of this alleged phenomenon has been vouchsafed, even by the discoverer, but it is safe to say that, in the present advanced condition of electrical science, it will not be long before a matter of so much practical importance—if true—will be sifted to the bottom, and the results published to a somewhat skeptical world.

THE preposterous schemes of a continuous street-railway from New York to Philadelphia and another from Washington to Baltimore, to be operated on the overhead trolley system, are just now receiving a good deal of attention in the columns of the local newspapers. It was once pertinently observed by a picturesque humorist, whose memory still haunts the purlieus of Wall street—apropos of a certain railway consolidation in contemplation at the time—that "you can't make a good omelette out of a lot of bad eggs." No more can a profitable through railway line be made by the combination—end to end—of a series of local lines having individually neither potency nor promise of ever meeting even their operating expenses. It is astonishing that people can be found to put money into such schemes, merely because they are labeled "electrical." We would sooner—much sooner—invest in a line of horse-cars over the same routes, because the permanent investment would be less.

IT is stated that ground has been acquired on the water-front in Baltimore for the erection of a mammoth electrical central station for the generation and distribution of light, heat, and power, which is designed to have an aggregate capacity of 12,000 horse-power.

A SUCCESSFUL application of the storage-battery for telegraphic service has been made in the Baltimore office of the Postal Telegraph Cable Co. It has been found that 500 storage-cells are ample to do the work heretofore requiring 2500 large gravity-cells. The cells are charged from the electric-lighting street service, by means of a small motor-generator of half a horse-power. The battery is divided into twelve sections which are charged in rotation by the motor-generator. The cost of maintenance of the gravity-cell heretofore used is given as $1.10 per annum, which cannot be far from the truth. An equivalent quantity of electricity, capable of doing the same work, when purchased at the ordinary rate from the electric-lighting company, costs about 9 cents. It is estimated that the positive plates of the storage-battery, under the service required, will not need renewal oftener than once in two or three years.

ARCHITECTURE

Conducted by Barr Ferree.

THE Frenchites have at last taken official root upon the free soil of America. And it must certainly be admitted that those architectural gentlemen who call themselves Beaux-Arts men show a most commendable industry and earnestness. Their efforts to fasten the academic spirit of contemporary French architecture upon the building geniuses of America have received fresh strength from the founding of the "Beaux-Arts Society of Architects" in the city of New York, and its incorporation in the State of the same name. A duly incorporated body is certainly formidable, and we lose no time in saluting the present organization, originally started as a sort of alumni society on a most liberal scale, for it appears that all who have been 'received as pupils at the École des Beaux-Arts of Paris in the department of architecture, and are pursuing the profession of architecture, shall be eligible as members." It would seem that more than the simple passing of the entrance examinations at the Paris school should have been required for membership in this society, for it is reasonable to suppose that it would be easier to "cultivate and perpetuate the associations and principles of the École des Beaux-Arts" by insisting on a certain amount of work at the School. This, however, is entirely the business of the society, and it may be accounted sufficiently responsible for its own notions to pass on the individual merits of its own members. It is impossible to deny that the possibilities for harm and for good in such an organization are very great. An active and agressive campaign in which "France for the Frenchites!" shall be the battle-cry could most effectually put a stop to all hope for American architecture, and reduce our own work to the dullness of that of contemporary France. On the other hand, by culling out the good features in the French system and applying them to American conditions, the society could accomplish a corresponding amount of good. Neither of these courses are hinted at in the constitution and by-laws of the society. We note that the *American Architect* is at a loss to understand why the gentlemen composing this new organization should get together by themselves, far from the other architectural organizations. Is it possible that the *American Architect* does not appreciate the significance of the Beaux-Arts movement? What is the *Architectural Review* doing that its near neighbor is so plunged in medieval darkness? We would respectfully call the *Review's* attention to the *Architect's* condition and beg it to enlighten it. For our own part we view the society as a good sign of the times. It is well that the Beaux-Arts men should get together by themselves, and listen only to the sacred voice of the Beaux-Arts prophet extolling the excellence of the Beaux-Arts product. It is well also that they should be known apart from others, so that when the great American public, seeking out practical buildings in a practical age will know whom to go to in order to obtain the most extravagantly-planned buildings designed in the latest Parisian styles. We note that "any one who by reason of his efforts and assistance shall have contributed to the welfare and success of this society and the attainment of its objects and aims shall be eligible as an honorary member." The editor of the *Architectural Review* cannot—alas!—be a member of the society, but he clearly deserves honorary membership. We beg leave to nominate him for that distinguished honor from the hands of the Beaux-Arts Society of Architects.

"IF it is asked us," remarks the *Archi-*

tectural Review, in replying to some previous remarks in these pages on its position on the education of architects, "What is a Fine Art? we can answer, It is an art operating upon a subject which is not necessary for the physical or material prosperity of man. And such are music, literature, painting, sculpture, and architecture." We must object to this. This is a subjunctive definition, and represents only the *Architectural Review's* way of looking at architecture and defining it. It is a definition that will not bear the test of history, and unless it does that all the wisdom in the world will not help it. And not only will it not bear the test of history, but it is absolutely contradictory to history. Architecture, in its origin, was not an art, or anything else "operating upon a subject which is not necessary for the physical or material prosperity of man." On the contrary, every writer on architecture should know, though the *Review* appears to be ignorant of it, that architecture originated in the effort of man to provide himself with shelter. Its origin was entirely utilitarian, though in process of time a freer use was made of the materials employed in it, and it assumed that phase which is commonly called artistic. This was a late development, and simply an outcome of the initial stage. And though we have long since passed this primitive stage and discarded its forms, we have not reached a point at which we can afford to ignore it in considering the meaning and value of architecture. We will grant at once that, on a definition that plainly ignores the facts of history, it is quite possible to erect any sort of a superstructure one chooses. When one undertakes to teach young men in the broadest subject under the sun, with an historical past that extends almost in a continuous line to the very advent of the human race upon the earth, and out of this vast epoch of time selects only a few monuments from the period nearest one's own, and seeks to bring the whole vast subject under a meaning arbitrarily given to them, it is obvious that almost any sort of theory may be suggested, any sort of belief formulated, any sort of practice put into execution—more pitiable than the spectacle of the blind leading the blind, for it is men of culture and of education, with the amplest facilities for acquiring knowledge, deliberately shutting out whole centuries of work and labor in order to erect an artificial fabric upon an artificial base to conform to a preconceived personal preference.

In many respects the problem presented by the high building is the most important now before the American architect. In no other land is this problem receiving so much attention as here, nowhere else are so many architects engaged upon it, nowhere else does such architecture bring such rich results to the practitioner. It is not the only problem the American architect has to consider, it is true, but it is certainly not second in importance to any other. Already it has become the typical building of America, although we as yet have only seen its beginnings. The engineering problems it involves have been amply treated by the engineer; its architectural treatment by the architect is still a matter of debate, while the question of its artistic treatment is, perhaps, the most difficult and least understood of all. Yet not wholly so, for a few architects have a number of times not only showed their understanding of the problem, but demonstrated their ability to treat it in a thoroughly successful manner. The Schiller Theater, of Chicago, to which reference has again and again been made in these pages, is, perhaps, the finest high building in the world. Certainly it has not yet been matched for grace and beauty of proportion, for appropriateness of elevation, for richness of decoration, applied in a thoroughly satisfactory manner. And the architects who made this building have made others equally successful and equally satisfactory in the manner in which they meet artistic requirements. This aspect of the question is as yet scarcely known in the east. The idea of a correct principle of high design which, when rigorously applied to a high building will produce successful and artistic results, does not appear to be admitted in New York, yet once the nature of the problem is understood, and its solution attempted on the lines suggested by this understanding, a satisfactory result can scarcely be avoided. The trouble lies in the gaining of this comprehension. Architects are so accustomed to low designing, to heights not exceeding six or seven stories or less, and into which the element of width enters in a more or less definite manner, that they seem unwilling to cast aside the traditionary methods acquired in such work when they approach a problem that is three times as high as it is broad, or more, and that may range in altitude anywhere from ten to twenty stories. Such a problem is quite unlike anything ever before submitted to the architect, and it is no wonder that under the circumstances the failures should exceed the successes. There is, however, no reason in the problem itself why it should not be treated successfully, and a number of examples, chiefly in Chicago and in St. Louis, show how this can be done.

NOT to indulge in specific examples it is sufficient to note that, in making a high design, it is imperative that the architect start out with a full conception of the fact that it is something entirely new under the sun. There have been high buildings of various types and forms in various previous epochs, but nothing that in any way approaches the modern commercial high building, built not for art but for income, a monument, not to the honor of its builder, but to his wealth, and designed, not to perpetuate his name but to supply his descendants with a good rich income so long as the structure is kept up to the top notch of modern requirements and it remains in their unencumbered possession. We need not stop to enter into the multitude of details and the variety of conditions that surround the designing of the high building of to-day,—conditions and details so numerous and varied as almost to deprive the architect of his claim to originality. But granting the newness of the problem, the next fact to consider is that the high building, being a vertical building, must be treated in a vertical manner. In other words, a high front is something to glory in, not to be ashamed of. The introduction of horizontal lines, of variety of motifs, of piling on of features one over the other, are as much to be avoided in a logical consistent high design as if it were impossible to combine them. The verticality of the high building is suggested and insisted on, not only by the vertical lines of the steel frame on which the building is carried, but by the manner in which such treatment emphasizes the height of the building. It never pays to avoid the truth, and if a building is to be twenty stories high there is no reason in itself why each one of the twenty should not be shown in the façade. The high design, like every other design, needs to be treated in a reasonable manner, studied in the light of its own conditions, solved as they suggest. The high front, as has been the case with every other sort of front prior to the seventeenth century, must be a logical outcome of the building and its necessities. Limited by the momentary considerations which force him to build his façade on a straight line, the modern architect is unable to exhibit exteriorily the diversity of plan that is possible in buildings planned on a freer system. To be successful the architect must rid himself of all his preconceived notions. He must admit the question is new, he must rid himself of the idea of proportioning a front whose size is given him at the outset, he must perceive that only in a very limited sense of the word can he express his plan outwardly, and perhaps not be able to do so at all; and he must further be prepared to maintain that as the high building is new and is not found in the historic styles, he must dispense with them save in the way of detail. Thus equipped it will be possible for the thoughtful and artistic architect to produce successful and artistic high buildings, and when this becomes general the chiefest disgrace will be removed from the street architecture of the contemporary American city.

THE question of women architects is assuming greater importance every day. Already, perhaps, we have the woman architect, since several edifices have been erected from the designs of women, and one or two architectural bodies have seen fit to set their seal of disapproval upon such people. The Architectural Association of London has been the latest organization to debate the admission of women to its sacred fold, with the result that, by an overwhelming vote, they were forbidden even a peep within the holy enclosure. It is not likely that this disastrous decision—yet it must be confessed it carries with it the weight of most august authority and conservatism—will have any effect in diminishing the supply of draftswomen. Of themselves there can be no reasonable objection to draftswomen—we are a little doubtful whether this is the word to use or not, but presume it will pass muster—provided they will perform the same work that men do, in as good a manner and for no higher wages. The average woman employé is more reliable than the average man employé, and there is no reason at all why, simply because a person is a woman, she should be debarred from following the pursuit of drafting if she has a natural aptitude for it. From draftswomen to woman architect is quite a distance, and it is in bridging this that the greatest difficulties are likely to be interposed and the greatest opposition manifested. The question is not a complex one, however, and surely, if men cannot maintain their supremacy as architects without legislating the women outside the profession, the sooner they experience the competition with women in their own profession the better it will be for art and the public at large. We must, however, protest against any notion that architecture is a "lady-like" art, easy to practice, and "genteel." Architecture is an extremely difficult and complex profession, requiring the widest knowledge and returning success only through the most arduous exertions. One extremely potent cause for much of the bad architecture of the day is the need of a broader education by those who practise it. The women must not permit themselves to be attracted to it because it so "easy."

DRAFTSWOMEN in America are likely to increase largely through the opportunities of study afforded by the New York School of Applied Design for Women. This is one of the newer educational institutions in the metropolis and has been founded to provide working girls with the means of learning artistic modes of support. The architectural section is only a small part of the work the School has undertaken, instruction being offered in carpet and wall-paper design, in book-covers and in other allied forms of decorative art; but the architectural school is the only portion we are concerned with. This is conducted by architects and draftsmen from some of the leading offices of New York, the aim being to give the students the benefits of practical and actual experience. Other instructors are similarly practical men who give up a few hours a week to the supervision of the work, and the school is thus enabled to offer a more thorough course in practical art work than is provided by any other institution in New York, and on a system wholly different from that in which the work is directed by a professor who has long been a stranger to the realities of the work he is teaching. Although only in the first years of its existence, the New York School of Applied Design for Women has made a most creditable record for itself. Its system of training is, of course, the theoretical one of the Beaux-Arts and its American allies, but within the limits thus set its students show a most commendable industry, a skill proportionate to the time they have given to their work, and, in some cases, a marked degree of artistic talent. There is no reason at all to doubt that when the School has been a little longer in operation, when its courses have been further systematized and its students have had the advantage of several years' training, its graduates will be fully as well equipped to enter architects' offices as assistants as the graduates of any American school of architecture. How far this School may help in determining the question of the women architect in America is not yet clear. Its aim at present is only to train draftswomen. The higher grade may come in time, but when it does there is every reason to believe that those who seek it will be fully aware of the difficulties they must contend with and the battles they will have to fight, not only for themselves, their profession and their art, but to gain the business whereby they may earn a livelihood. In commending this School and its students to our readers it is just to add that its success is chiefly due to Mrs. Dunlap-Hopkins, chairman of its board of managers, who has interested not only herself but many others in the school, and who has already had the very enviable satisfaction of finding her efforts crowned with success.

A VERY great deal of interest has lately been manifested in New York over the competition for a twenty-story office-building for the American Surety Company, to be placed on an 85-foot lot on a corner site adjoining the Equitable building. Nine architects were invited to take part in the competition, viz., Messrs. McKim, Mead & White, George B. Post, Carrère & Hastings, Bruce Price, LeBrun & Sons, R. W. Gibson, W. Wheeler Smith, John R. Thomas, and G. Martin Huss. Mr. Richard M. Hunt was the professional adviser of the company, and the building was finally awarded to Mr. Price. Whether it was from the known inclination of the professional adviser or from the personal inclination of the competing architects, it was somewhat significant that classic or Renaissance designs predominated. The richest and most elaborate design and of most extraordinary merit in itself was that of Messrs. Carrère & Hastings; one of the severest was that of Mr. Bruce Price, to whom the building was awarded. It is possible there may be a lesson in this and possibly not. At least it is certain that never before were classic structures designed to be built twenty stories high, and the chief interest in the competition arises from the various uses made of classic motifs by the competing architects. Without entering into specific illustration in the least it is sufficient to state in the broadest way that the method selected was to introduce motifs of three or four stories decorated with different orders, in engaged columns or with pilasters, filling up the space by the introduction of entresol stories and other devices to fill out the total number of stories. The difficulty of the problem was further complicated by the relatively small size of the lot. This was only about 85 feet square, so that the building naturally assumed tower-like proportions. Somewhat fortunately the adjoining structures to the south and east, from which points the building will be readily seen from the bay, are of such a nature that several of the competing architects suggested carrying the same motif around the whole of the upper part, thus making the building an actual tower, and this idea, we understand, will be applied to the design selected for execution. It was perhaps somewhat significant of the natural tendencies of New York architects towards the horizontal in all things, as well as a practical illustration of the unadaptability of the classic to very high structures, that only in one design, that of Messrs. Gibson and Smith, was a style selected that permitted vertical treatment. Even this did not go as far in the vertical direction as it should, but it was a most interesting study. Whether this competition will have any permanent effect on the betterment of New York commercial architecture remains to be seen; meanwhile the decision of this company to build so high a building will quite likely be followed by others, until the problem of New York's restricted area shall have been solved by the upward tendencies of its buildings.

THERE is no reason at all why newspaper reporters, whose lives are spent in making observations and in ferreting out facts,—albeit the facts would sometimes be better without the ferrcting,—should write successful magazine articles of observation and of travel, but it is quite natural that, after series of such papers have been written, the results should be put into book form and thus given a dignity they may not have had in the more perishable state of newspaper and periodical literature. It is not often that this process produces such a notable work as Mr. Julian Ralph has accomplished in his book* on the West. Dealing primarily with the present conditions and future possibilities of the new commonwealths of the United States, it contains a quantity of interesting details on the cities of the west to which the student of municipal development, in which the architect has so important a place, may well give his attention. Quite naturally, in speaking of Chicago, Mr. Ralph has a good deal to say of its office-buildings and the general architectural characteristics of the city. Without undertaking to critically treat these splendid monuments of Chicago push and energy, Mr. Ralph is quick to recognize the fact that the development of the high office-building has reached a more notable stage in Chicago than in New York. "It is a great mistake," he writes, "to think that we in New York possess all the elegant, rich, and ornamental outgrowths of taste, or that we know better than the west what are the luxuries and comforts of the age." But with all his breadth of view he is unable to understand or appreciate the merits of the purely commercial designs of which Chicago has an unusual number, for he tells us that some of them "are artistically designed, and hide their height in well-balanced proportions. A few are mere boxes punctured with window-holes, and stand above their neighbors like great hitching-posts,"—a complex simile that no one but a newspaperman would think of using. The general criticism is wrong, for there is no reason why a high building should hide its height in well-balanced proportions or in anything else. Height is not an element to be afraid or ashamed of in a high building, though as one brought up in New York there is no wonder Mr. Ralph thinks so. But this is a detail in specialism, perhaps, for which our author should not be held too strictly accountable. The book is a most impressive picture of the great west and will unquestionably do a vast deal of good in familiarizing people with the resources of a large part of our country that is too of much a closed book to the traveled American.

* *Our Great West*. By Julian Ralph. New York: Harper & Brothers. 1893.

In The Engineering Magazine for September, 1891, in an article on "Recent Tendencies in Architecture," we find the following statements:

> Exaggerated edifices are bad enough in their way, but when no attempt is made to conform to the exacting on conditions of height they become positive inflictions. The Tower building . . . is one of the most conspicuous illustrations of this grade of work. In it the architect has exaggerated every line which tends to increase its apparent height and unfortunate narrowness and the result is almost painful. . . . . . In all the upward tendency it has been greatly exaggerated.

True enough, so far as the Tower building is concerned, for it is one of the most distressing designs in New York; or rather it was when it was built, for the nerves of the passers-by are set on edge by many a more striking monster built since then. In *Scribner's Magazine* for March, 1893, the same writer in an article on "The High Building and its Art," has this to say:

> A high building is necessarily big; it cannot be hid, nor can it by any physical process be made smaller than its physical bulk necessitates. If the high building is to be an artistic success this quality must be admitted at the beginning. Notwithstanding this, many architects, especially in the seaboard cities, apparently believe they can make the impossible real, and reduce the apparent height of the high building by dividing it horizontally as often as their imagination or taste will permit. . . . . . If he [the architect] cannot treat verticality as an artistic quality he must learn to do so, just as he has had to learn every other step in architectural progress. . . . . . Vertical design being the natural system to be followed in high façade design, in which the superstructure naturally grows out of the basement, and, in turn, forms itself the natural base of the crowning frieze, a similar following of natural law offers the safest guide in the determination and use of ornament.

Conducted by Thomas L. Greene.

THE shocking accident on the Delaware, Lackawanna and Western railroad at Hackensack meadows, in January, by which twelve persons lost their lives and many were injured, brings up a number of important questions of railway policy. This company has long been prosperous, principally on account of its coal traffic. The beautiful country through which it runs for twenty-five miles out of New York city has led many New-Yorkers to make their homes there, so that the Lackawanna enjoys a large commuting traffic. It has been operated generally on old-fashioned methods, not having changed its policy with the gradual advancement in operating management on the neighboring roads. The Morris and Essex division has not before had a serious accident, its immunity being due largely to the painstaking oversight of the officers and the excellent character of the employés, many of whom have been in the service of the company for over twenty years. The theory of the company has always been " men rather than machines."

It seems clear enough, however, that the Hackensack disaster was due primarily to the absence of a block system. The oncoming engine-driver was running his train in the fog faster than the preceding train which he telescoped, but no evidence has been produced to show that he was guilty of extreme negligence. The rear brakeman had started back to warn the approaching train, but was too late. The real fault lies upon the company, which, by not earlier adopting a system of signals, left the engine-runners in ignorance of the position of trains in front of them,—information to which they were justly entitled. Since the accident the Lackawanna company has contracted to put in the Hall track-circuit system of signals in half-mile blocks from Hoboken to South Orange, and the signals are to be extended gradually to cover the whole road. The time-table of the Lackawanna has trains within four minutes of each other. Experience shows in such cases that one of two things is likely to happen: either the schedule time is not kept, or trains, on mere flag protection, are run dangerously near each other. It is a peculiar advantage of the block system, in cases of crowded traffic, that by its aid trains can run at shorter intervals than before, and yet with greater speed and safety. In time, four minutes is but a brief interval when trains are running rapidly; but four minutes at sixty miles an hour means a space interval of four miles. We may allow trains within a mile of each other if we are sure of our apparatus, and that they will under no circumstances approach nearer; but we can never be sure that trains run on the time interval are keeping that number of minutes apart. Moreover, in blocking, we substitute a signal at a fixed spot, where runners get accustomed to look for it regularly, for a signal by flag or torpedo at unexpected places, and which indeed may never be given when most needed. The motto " man *versus* apparatus " should be changed to " man *and* apparatus."

It has not been sufficiently noticed in the newspapers that to all the horrors of the Lackawanna wreck fire was not added. Every one will recall instances where the broken cars caught fire from the stoves, perhaps subjecting the injured and imprisoned passengers to a horrible death. To the credit of the Lackawanna it should be stated that the company had already adopted the plan of heating the coaches from the engine by the Gold system. In the Hackensack accident this improvement saved much suffering and perhaps many lives. There is no excuse for the "deadly car-stove" since experience has demonstrated the feasibility of heating the coaches by locomotive steam. It is announced that the Baltimore and Ohio are about changing the heating of all their equipment. Such roads as the New York Central have already done so.

ANOTHER matter which the Lackawanna disaster brings up is the strength of our passenger coaches. Of course nothing can withstand a hard blow from a rapidly-moving train, but there is evidence in plenty that a more careful building of passenger-cars will do much to check telescoping. Some of the coaches run by our railways are mere shells, whose frames are just strong enough to hold the car together in ordinary running. This ought not to be so. It has often been remarked that Pullman or Wagner cars have withstood the shock of collisions which have wrecked the ordinary coaches in the same train. Cheapness is out of place in the construction of cars in which passengers are conveyed and which at any moment may be the only protection of travelers from death or injury. Another thing in the same connection is the value of the vestibule device. Not only do cars with this attachment ride more smoothly and comfortably, not only is the passage from car to car thus made easy and safe, but cars so fitted out bear up better under collisions. When we read that one car in the Lackawanna accident was forced almost entirely through another, though the train had slowed down to fifteen or twenty miles an hour, we are compelled to think that the time has come for new methods and new standards in the car-building department of our railways.

IN a paper read recently before the New England Railroad Club, Professor C. Frank Allen, of the Massachusetts Institute of Technology, gave some fresh figures on an old but always important subject: the dollar-and-cent disadvantages of grades and curves. The relation between the building or improvement of railways and the resulting effect upon the economy of operation has of course long been studied by civil engineers, but, if we except Mr. Wellington's book, the subject can scarcely be said to have a literature. After quoting the census figures of cost of running a train one mile, divided by groups into fixed and variable, Mr. Allen properly says that many of these items—such as station expenses—will not be affected by one mile extra distance; coal will be increased and so will car-mileage, as well as track-repairs. Train wages, if based on miles run, will be increased, and so, though to a less degree, will car- and engine-repairs. If then we assume $1 as the average cost per train-mile, Mr. Allen's estimate of the train cost for an extra mile is 35 cents; at 80 cents average cost, the extra mile would add 28 cents. One train each way per day, or 730 per year, would, therefore, at 28 cents, amount to $204.40. This capitalized at 5 per cent. would be $4088, the amount which the civil engineer can afford to pay to avoid the mile of distance at two trains per day. At ten trains this amount of course would be five times as much. So much for operating expenses, but other things must be considered, such as the effect of the odd mile in pro-rating or in the fares received if so much a mile, etc.

PROFESSOR ALLEN'S estimates on curvature are that at 317 the extra cost per train mile is 24 cents. One degree is estimated at 8 cents per train mile, or 58 cents for one train each way; for 10 trains $5.80, amounting if capitalized to $111.68, which may be spent to avoid that one degree of curvature.

On gradients, the estimates are based on an operating division 100 miles long, and only those trains are taken whose loads would be thus lightened throughout the entire division. It is also assumed that the question is between a 37-feet and a 53-feet grade, and the engine an average consolidation locomotive. At 80 cents for the average cost of trains, and for ten trains daily, capitalized at 5 per cent., the amount reaches $1,600,000 of capital. In known cases the exact disadvantage can be calculated. Mr. P. H. Dudley made some calculations on the Lake Shore which showed that if the train resistance could be reduced one-quarter, a saving in operating expense of $750,000 per year would follow. Even the difference in train-resistance, as between iron rails with low joints and steel rails with good ballast and ties, was found to be as high as 57 per cent. "The engineer who figures only upon the comparative cost of heavy and of light rails for a series of years stops far short of his duty."

AFTER further discussion of yard terminals and the like, Professor Allen closes with a plea (1) for the better attention of civil engineers to this branch of their profession, and (2) for the attention of railway managers to the importance of this kind of work when done by competent hands. The question is often asked, in view of the decline in railway building, whether the profession of civil engineering is any longer a good one to follow. But this is not the real question; that question is whether the young engineer is willing to confine himself to one branch of his trade. Unless all signs fail, the railways of the United States have entered a period of low earnings; the burning wish is to reduce operating expenses, not merely by discharging hands, but by economics founded on scientific principles. The civil engineer who can demonstrate such savings without sacrificing efficiency will find the whole field open to him; but he must change his studies from railway-building to railway-operating.

AS a corollary it may be safely stated that the need of the average railway manager today is technical knowledge. "Practical" railway-men have long held sway, but now is the time for the theorist. The railway world, if it appreciated its real position, would demand men who know how to combine and classify the facts which the rule-of-thumb officers have learned in their long experience. In short, railroading is more and more getting upon a scientific basis where principles can be evolved from the facts collected, and where trained observation can be directed towards cheapening the cost of running and handling trains. For this effort the civil engineer and the mechanical engineer are fitted by their preliminary education; but they must apply their knowledge strictly to the questions at hand.

THE New York State board of railroad commissioners have applied themselves intelligently and conservatively to the study of some of our railway problems. There is the problem of grade-crossing, for example. We frequently hear of the killing and maiming of persons at highway crossings. One road in New York State has 1300 such wagon-road crossings at grade unprotected and 460 with gates or flagmen. Moreover, fast trains add greatly to the danger, for a train covering 120 feet in a second runs a quarter of a mile in ten seconds. Drivers of wagons may think such a train a long distance away and attempt the passage, while in reality the engine is almost on them.

But the enormous cost is the great difficulty in the way of removing such crossings, and, though it may sound cold-blooded to say it, it is true that safety is largely a commercial question and has its price. If the people want the abolition of grade-crossings they must pay for it in some form. The New York board suggest that no new road be allowed to make a new grade-crossing. As to existing crossings, the right of the company to its position is recognized. The Massachusetts law has worked out fairly well. It divides the cost of removing grade crossings between the town, the railway, and the State as representing the traveling public. The minimum share paid by the State is 25 per cent. and by the town 10 per cent.; the former may be increased and the latter diminished. The remaining 65 per cent. is paid by the company. Massachusetts appropriated $500,000 yearly for ten years, which has not all been spent. Here is a practical example which has not caused the comment in other States which its merits deserve. In England, as we know all crossings are eliminated when the railway is built; but on this and other accounts the capitalization of railways in Great Britain is over $200,000 per mile.

Another most appropriate suggestion of the New York commissioners is that crossings of electric- and steam-railways should be protected by interlocking plants. The multiplication of trolley lines in the country adds greatly to the dangers of crossings where these and the steam-railways meet, if no safeguards are provided.

ASIDE from the cut rates and railway wars with which we are familiar, and aside also from steady reduction in receipts brought about through federal and State legislation, an unsuspected cause of decreased revenue is made public in *The Station Agent*, by Auditor McCain, of the interstate commerce commission. This is the decrease of revenue from changes in freight classification. In 1886, the year before the interstate act was passed, but 15 per cent. of the articles named in the classification east of the Mississippi river had lower rates for carloads; now 62 per cent. are so favored. There has also been a gradual but persistent fall in rates from a lowering of classification by items, indicating in each case a lowering of rates. The percentages are stated by Mr. McCain in tabulated form as follows:

	Classification of 1886.		Classification of 1893.	
Total no. of descriptions	1,000		5,600	
Proportion 1st class	32%	67%	22%	53%
Proportion 2d class	24%		12%	
Proportion 3d class	11%		19%	
Proportion 4th class	31%	33%	19%	47%
Proportion 5th class	2%		23%	
Proportion 6th class	0		5%	

In 1886 the number of articles charged in fourth-class or lower was 33 per cent. of all; in 1893 the proportion had risen to 47 per cent. In 1886 the average rate on all articles from New York to Chicago was 63 cents; in 1893 it was 48 cents. This is a proof, if another was needed, of the steady whittling away of railway revenues which, if not checked or met by scientific economies, will work disaster to the capital now invested in our companies. Nor should we rely for a defense upon a return of prosperity and of a larger volume of traffic if unaccompanied by more fairness to our carriers. It is the margin of profit, now too low, which should be increased. The interests dependent directly or indirectly upon transportation are so vast and important as to make this reflection of grave moment.

MR. C. P. HUNTINGTON has written another letter in which his former opinion is repeated that no new lines of railway are likely to be built in Texas so long as the present harsh opposition to railways continues there. It does not throw doubt upon Mr. Huntington's prophecy to find that several hundred miles of road were actually constructed in that State in 1893, because this mileage was built by the Rock Island and Kansas-Texas companies as extensions of lines necessary to complete their systems. Capital is very timid now from well-known causes, and surely none of it can be secured in favor of any new enterprise in States which seem to hold, in practice if not in theory, to the socialistic doctrine that capital is a form of robbery. Since in such States it is not their own money which is imperilled by drastic legislation, it is easy to suppose that any compulsory lowering of profits will not hurt the home people. Usually it takes some degree of clear thinking, and perhaps experience, before the western or southern farmer sees that an injury to the railway is in the end an injury to himself.

ADMITTING that some restraining legislation is allowable—though even this is economically doubtful—it seems strange that but few States have tried the remedy of greater freedom. If banks charge high rates of interest on loans the best course is not to attack the banks, but to welcome more of them by enacting laws which shall afford all reasonable protection to the lender. The safer and better the loans the more will banks compete for them, if allowed to, with a consequent gradual decline in the rates of interest paid. In like manner oppressing the carriers merely prevents other railways from coming into the territory, which would be certain to be the result if the profits were unduly high. The commercial test is slow but sure. Combination for a while may arrest a decline to the common level of profits, but only for a while. Combinations among modern industries are formed to prevent insolvency rather than to extort high charges. The tendency of the age is entirely on the side of the consumer, and no oppressive laws in Texas or elsewhere are at present needed to hasten the movement. But reduced train service and lower wages—or an equivalent in a smaller number of men employed---will inevitably follow a loss of profits. There was a time in our economic history when in every purchase and sale one party or the other was supposed to have lost something. We now believe the more enlightened theory that trading benefits both parties. Applying this principle to the State's relations to carriers, it is to be observed that if the State would prosper in all its interests the railway must prosper with it.

THE interstate commission in its annual report renews for the third or fourth time its recommendation that a uniform classification of freight be made compulsory by law, and that the commission or some public authority be directed to enter upon the work. In spite of this recommendation, it is well to make haste slowly. Undoubtedly the three or four different classifications now in use ought to be brought into uniformity as fast as commercial conditions permit, but no faster. The inconvenience arising from their differences is partly exaggerated and partly ineradicable: rate-quoting for long distances must always remain in railway hands, because dangerous in any other. The ease in figuring out a combination rate under a national and common classification would be secured at the expense of that more important quality, conformity with trade conditions. The division of articles into classes is merely an aid in fixing their rates. In short, classification is rate-making. Now, the art of rate-making consists in conforming tariffs to the facts in each case. These trade facts and circumstances differ in different sections of our country. Cotton is a staple in some States, and wheat or corn in others. The laws of good trading require that a staple crop yielding large tonnage should be carried more cheaply than the occasional shipment. Hence cotton is carried at a proportionately lower rate in Georgia than in Minnesota, with wheat *vice versa*. These cannot be put in the same list of articles in the north and the south without doing violence to commercial common sense. In the same way both rates and classification are lower in the trunk-line or eastern territory than in the States west of the Mississippi, for the reason that the volume of traffic is lower in the east and the pressure of business competition greater; so the railway schedules conform to the facts. To put these two classifications together would be convenient, but might do a commercial injustice. Of course the railways of each section, after adopting a universal classification, would try to obtain their usual revenue by readjusting class rates so as to fit the changes, so far as possible; but practical railwaymen know that commodity rates as they are called—special rates on special articles for special reasons—would quickly nullify the supposed harmony, leaving marters just where they are now. The true position to take is that harmony in classification of freight should follow—not precede—the approach of equality in the business conditions and scale of profits of the different sections of our country.

MECHANICAL ENGINEERING

Conducted by Henry Harrison Suplee.

"ENGINEERING," said the veteran James Nasmyth, "is common sense applied to the use of materials." Coming, as it does, from one who was the most practical of mechanical engineers, and yet who at the same time rated theoretical research at its fullest value, this definition is worthy to be borne in mind more than ever at the present time, when theory and practice are constantly shifting, when the theory of yesterday is the practice of to-day and may be shelved to-morrow, and when the "common sense," which has been said to be one of the most "uncommon" things in the world, is more to be desired than ever. But "common sense applied to the use of materials" is not so uncommon a thing after all, and it is one of the encouraging signs of the times that the so-called theoretical man is becoming in many ways very practical and the practical man truly and sensibly theoretical, and that the noble art and science of engineering is being mightily advanced thereby.

AN excellent instance of the blending of theory and practice is found in the increasing use of measuring appliances of precision in the work-shop. The skilful lathe hand makes his "running," "shrinking," or "forcing" fit by the use of a pair of calipers, a delicately-trained sense of touch, and a judicious admixture of common sense. The writer well remembers how just such a practical man rather objected to the idea of calculating the proper allowance for such dimensions, and, instead of antagonizing him, he was induced to permit the results of his skill and experience to be placed on record by having very careful measurements of a number of shrinking fits made by him tabulated for reference. When he was subsequently shown how closely the measurements of his "practical" allowances agreed with the professor's theoretical calculations his feelings first expressed themselves in pleased congratulations to the professor upon the fact that his calculations were so nearly correct, and this frame of mind was soon followed by a sense of personal pride in the fact that he himself ranked with the educated theorist as a peer and a companion. Since that time—for it was a number of years ago—the use in the work-shop of closely calculated dimensions has become sufficiently common to cease to attract attention, but there are many ways in which a similar union of practice and theory ought to be made.

STANDING one day not long ago under a modern high-speed electric traveling-crane, it was impossible to avoid commenting upon the ease with which the operator steered the heavy burden which hung upon the hook between the various obstructions upon the erecting floor. By a judicious combination of bridge and trolley motions with occasional hoisting and lowering, the hook and its load threaded their way rapidly down the long building. The man in the "cage" had thoroughly mastered the combinations of the three "variables" of the three-dimensioned space in which his work lay, and had not only learned to think in three dimensions, but had also grasped the fundamental meaning of the "rate" of speed involved in the description of the curved path of the load.

It would have been a most instructive lesson to any professor of differential and integral calculus to gaze silently at this practical illustration of the combination of variable values into a curved path. The workman's use of his grasp of the laws of motion as expressed and limited by the rectangular coördinates in the instance of a traveling-crane is in many respects as scientific and complete as the mathematician's use of his command of the calculus. Indeed, the true use of mathematics in engineering is to obtain results which shall be applicable in practice, or to investigate phenomena which have already been observed and demand solution in order to be available for future use. Some day we shall have for the use and service of the practical man such useful and intelligent treatises upon practical mathematics as the masterly works of Lubsen, and when the practical workman finds in the books of the student clear and intelligible answers to the problems which every day confront him he will require no other incentive to become an earnest student with his head as he has already been with his hands.

THE subject of the availability of electricity as a motive power for main-line railway service has been recently discussed in Germany by the *Verein fur Eisenbaukunde*, and Herr Ober-Baurath Stambke in the discussion brought out the following points of criticism against the steam locomotive :

1. The weight of the locomotive and consequent loss of efficiency due to the power required to propel the engine itself, especially at high speeds.

2. The loss due to the inertia of the reciprocating parts, and the increasing danger at high speeds from this source.

3. The effect of the centrifugal force of the counterweights in the driving-wheels, this limiting the continuous safe speed to about sixty to seventy miles per hour.

4. The inferior economy of locomotive boilers as compared to that of the forms available for use in power-houses in stationary service.

5. The fact that in the present forms of locomotives increased power can be obtained only by later cut-off and consequent reduction in economy of use of steam.

Against these points the following advantages possible in the use of electric power were cited :

1. The total absence of weight of electric energy itself, and the slight weight of the apparatus for transmitting it from the stationary point to the moving body.

2. The absence of necessity of a special locomotive engine, it being possible to apply the power to the axles of each car, thus utilizing the adhesion of each car instead of depending upon that of the locomotive only.

3. The higher economy attainable with a stationary steam-plant in nearly every respect as compared with the same amount of power generated in locomotive engines, together with the fact that only the motors are carried on the cars and not the entire plant.

4. The possibility of utilizing natural sources of power, such as water-power, as the propelling power.

5. The use of rotary instead of reciprocating motors, thus dispensing entirely with the objectionable reciprocating parts.

In discussing these points Herr Stambke admitted freely that the present state of the art did not admit of the substitution of electricity for steam as a motive power for main-line traffic, but suggested that it should be introduced upon feeder lines connecting with the stations of the present steam roads, thus paving the way for ultimate adoption on the main lines.

THE successful start which has been made of the turbines of the great paper-mill at Niagara Falls, forming as it does the initial step in the utilization of this great natural source of power, will be watched with especial interest from the fact that it is but a preliminary to the far greater experiment of the installation of the plant of the Niagara Falls Power Co., which is expected to be inaugurated next summer. The wheels of the paper-mill have nothing in common with those of the power company except the fact that they discharge into the same tunnel and open under practically the same head, being placed in a separate shaft and being of a different construction as well. At the same time the conditions are sufficiently similar to enable valuable information to be obtained as to the working of such wheels under so great a head, and thus to contribute toward the greater certainty of success of the main enterprise.

The greatest care has been taken to prevent any solid bodies from entering the inlet and thus getting to the wheels, the water being practically filtered through a system of intercepting devices well calculated to detain anything which might possibly cause injury. It will be most interesting to observe to what extent the action of ice nodules will affect the wheels, this being one of the uncertain elements which experience alone can resolve. As one of the most eminent of the engineers connected with the enterprise remarked, there is a vast amount of guessing involved in an installation of such magnitude, notwithstanding all the care which may be given. The entire absence of precedent for many of the points involved requires many questions to be determined almost entirely by the judgment of those having the work in charge, and there is here ample evidence of the exercise of that "common sense applied to the use of materials" which is indeed the highest attainment of the engineer.

THE interesting paper which was read at the recent gathering of a number of members of the American Society of Mechanical Engineers by F. F. Hemenway, upon the subject of "Steam-Engines at the World's Fair," developed a discussion which may be said to furnish some indications as to the lines of steam-engine construction upon which the future advances may be expected.

With few exceptions, the engines exhibited at Chicago revealed rather the slow but sure gain resulting from the careful application of well-known methods of construction than they did any startling novelties in design or invention. Extremely high rotative speeds were the exception, although the average speed has undoubtedly been materially raised during the years that have elapsed since the Centennial Exhibition. The standard of economy has steadily crept upwards from the thirty pounds of water per horse-power of eighteen years ago until fifteen pounds has come to be considered "good," with thirteen pounds and a small fraction just before the designer's eyes, like the proverbial bunch of hay before the progressive nag to urge him forward.

AMONG the few exceptions in modern steam-engines noted above, the so-called "steam-turbine" appears to offer possibilities which may work a notable revolution in the design of steam motors. When we attempt to realize the fact that the steam-turbine is claimed to be capable of operating successfully with a steam economy and range of expansion practically equal to the average high-class reciprocating engine, and to possess all the advantages which the most sanguine inventor of the bygone rotary engines ever ventured to claim, and, furthermore, to do this at a velocity of 25,000 to 30,000 revolutions per minute; when these claims are seriously brought forward and their substantiation reasonably assured, it is indeed time to wonder whether at the next exposition the Allis quadruple-expansion engine may not appear as antiquated beside its impending rival, as did the once famous Edison "Jumbo" dynamo, mounted upon its pedestal in the center of the Electricity building in the midst of its successors. There seems to be little doubt that the steam-turbine is to be the next in the field, if indeed it has not already arrived, and the next few years may see transformations in this direction which can now only be imagined.

ONE of the interesting transformations which has taken place in modern engineerng practice rather quietly, but none the less definitely on that account, is the subdivision of motors in many instances, in preference to the use of transmitting devices for the distribution of power. This has become the case notably in the later forms of cranes and hoisting machinery. The earlier types of power cranes, whether jib or power travelers, were constructed to receive the power from a stationary source using flying rope, square shaft, or similar transmitting mechanism. In traveling-cranes the power then required subdivision to perform the various functions of hoisting and lowering, trolley travel and bridge travel, which, together with the provision for necessary changes of speed, reversal, etc., involved many parts and constant complication, so that such a crane has rightly been called one of the most highly organized machines in use. The advent of electricity as a means of transmitting power soon became apparent for use in such cranes, but at first it was used merely to transmit the power from the stationary source to the moving bridge, a single motor furnishing the power which was then subdivided by mechanical appliances as before. This intermediate stage, however, was soon succeeded by the more recent forms in which a separate motor is used for each function, the multiplication of motors being found decidedly preferable to the use of the mechanism otherwise necessary. The great electric traveling-cranes in Machinery Hall at the World's Fair, being made with two trolleys on one bridge, contained five motors, and each function was thus altogether independent of the others, all being controlled from the operator's cage with the greatest ease. This principle of subdivision is also seen in power steam-cranes, in which three independent, double-reversible engines have been found preferable to a single engine and clutch-transmitting mechanism. In rolling-mills, saw-mills, electric-power plants, and many similar situations, the advantages gained in the reduction, both in first cost and especially in cost of operation and maintenance by dispensing with much of the power transmitting mechanism, has been found to offset fully the slightly lower efficiency of the smaller engines, while the freedom from entire stoppage in case of breakdown is a feature which appeals especially to the practical man.

Probably this practice of the subdivision of power by the use of many separate motors is carried to its farthest extreme in modern ships of war, in which over one hundred auxiliary engines are sometimes found. This practice also brings out a point too often neglected by designers of power plant, viz., that the ultimate economy of the entire plant should be always kept in view, and should dominate the question of economy of any portion; it profits little to save 10 per cent. in the engine and waste 20 on the line-shafting.

THE many exhibits at Chicago revealed some curious contrasts to those who were interested in the historical side of engineering development, but among all the phases of the art of directing the forces of nature for the use and convenience of man, none, we may safely say, was shown at such wide extremes as the production of heat. In the great boiler-house by Machinery Hall were shown the most modern methods of burning liquid fuel; in the Electricity building electric welding and cooking by electricity claimed novelty at least in similar lines, but after looking at these one had only to turn his steps to the much-discussed Midway Plaisance to see performed before his own eyes the origination of fire in a few minutes by a half-naked South Sea Islander, using the primitive process of rubbing one piece of wood upon another. It did not detract from the interest of the operation to find that the ingenious and ingenuous savage expected to utilize the glowing coals he produced merely to light a cigarette which the observer was expected to furnish, and it was impossible to keep from reflecting upon the immense gap between the beginning and the following. The white pinnacles of Machinery Hall assumed a new meaning as they glistened before our eyes, and we tried to realize that in the smoldering sticks before us lay the cause, while yonder we beheld the effects, and we bowed to the smiling savage and handed him the cigarette for which he was still waiting; he had earned it many, many times over.

ONE of the noticeable features due to the continual introduction of mechanical appliances into every-day life is the increasing popular interest in mechanical subjects shown by many people who formerly would have paid little notice to such matters. Nearly every issue of the popular magazines contains matter which a few years ago would have been considered suitable only for strictly technical journals, while the publication of a magazine devoted to engineering and yet intended for general as well as professional readers would have been out of the question. It is not too much to predict that the next few years will witness a rapid advance in popular interest in mechanical subjects, due not only to the existing causes, but also to the constantly-increasing introduction of systems of distribution of power. It is said that the late Professor Clerk Maxwell, when he first heard of the discovery of the reversibility of the Gramme dynamo and the consequent possibility of using it both as a generator and a motor, said it was the greatest discovery of the century evidently perceiving the revolution it would work in the entire practice of the generation and use of power. Not only may the small manufacturer ultimately compete with the great owner in the economy of cost of power, but the individual workman may come again to the position from which the concentration of power in the factory has displaced him; while not very far ahead may dimly be seen the sociological changes which the general use of the forces of nature by all, as part of the general right of existence, must surely bring to pass. Meanwhile the education of the great public in matters mechanical will go on quietly, but surely and rapidly, and in the light of what has been done it may well be worth while to watch thoughtfully for changes, the certainty of which is admitted and the manner of which is rapidly being revealed.

THE question of standard screw-threads and gages, which, fortunately, has been settled for many years in this country, is still being agitated in France. there being as yet no satisfactory standard of screw-threads adopted for use with the metric system. In Germany a modification of the Whitworth system, adapted to the metric system, has been adopted by the State railways, while the system of Delisle, differing from the English and American systems, has been recommended by the *Verein Deutscher Ingenieure.*

A committee of the French Société d'Encouragement has recently issued a report upon this subject, and, in view of the importance of the matter, this being about the only really weak point about the metric system as at present used, we Americans can stand upon the further shore of comfort and system to which we have successfully attained and look with interest upon the efforts of the members of the committee to wrestle with this increasingly difficult subject. We say increasingly difficult subject, for, as the report truly says, the earlier dates at which Whitworth and Sellers attacked the subject greatly simplified the task to them, and at present there are at least six well-used systems in France and fifteen or sixteen in Germany. Nearly every railroad in France has its own system of bolts and nuts, and, as it has already been well said, it is very much easier universally to adopt a new system than it is universally to throw away an old one, so that probably the greatest difficulty that the advocates of the proposed system will have to encounter will be the discontinuance of the systems now in use rather than the approval of the new one. It must not be forgotten, however, that the introduction of the metric system itself into Germany is as recent as the establishment of the empire, and the difficulties in the present instance are no greater than they were then.

Of the system itself there is little to be said, as it is more the fact of its existence than its construction that is here to be considered. Briefly, the pitch increases regularly by intervals of half a millimeter, a screw of 1 millimeter pitch being 6 millimeters diameter, and being numbered 0; the next being 1½ millimeters pitch, 10 millimeters, diameter, and numbered 1, and so on up to 10½ millimeters pitch, 154 millimeters diameter, numbered 19. The thread is made of an angle of 60°, the section being an equilateral triangle reduced by one-eighth of its depth top and bottom—being in fact the Sellers section without modification, this being considered by the committee capable of being executed with much greater accuracy and uniformity than the rounded thread of the Whitworth system.

It will be interesting to observe how the proposed system is received by the engineers and constructors of France, as a good screw-thread system has for a long time been needed to complete the metric system for workshop use.

Civil Engineering.

Conducted by John C. Trautwine, Jr.

IN the days when Thomas Paine, patriot and theologian, was shocking the sense of propriety of his conservative neighbors by suggesting the utterly visionary possibility of an iron bridge, the as yet un-named "civil engineer"—if, indeed, he existed so early—might find himself called upon one day to design a church, the next to locate a road or canal, and the third to throw a bridge across a stream or to build a mill; and even down to the days when the railroad had proved that it had come to stay, we often saw one man combining all of the then-recognized offices of the civil, the mechanical, and the mining engineer with those of the architect. The electrical engineer had not yet been evolved.

To-day the vast extension of the engineering field and the enormous development of detail in each portion of it have necessitated a degree of specialization that could scarcely have been dreamed of by the generation just passed away. Yet it by no means follows that the several branches of the profession are thereby called or permitted to work independently of each other. On the contrary, it would seem that the more sharply defined their pursuits become, the more intimately they are compelled to coöperate with each other in any given work. A great railroad, for instance, calls into exercise the faculties of civil engineers of all classes.

A striking instance of this interaction of engineers in the several branches of the profession is furnished in that spectacular work by which the power of Niagara, a power which has hitherto ministered chiefly to the sentimental side of man's nature and—in days not long gone by—to the emolument of the harpies who victimized the visitors to the spot, is now being harnessed to more prosaic work in man's service. Here the civil engineer must study the river and the possibilities as to location; the skill of the mining engineer is required in the design and construction of the tunnel; the hydraulic engineer must investigate the water-power, and, together with the mechanical engineer, must design the 5000 horse-power turbines, some of which have recently been constructed by metallurgical engineers in the service of the great Cramp establishment at Philadelphia; and the electrical engineer must look after the matter from the top of the turbine-shafts, where the generators are to be placed, to the city of Buffalo, which is to be "lighted from the Falls," and to the numerous consumers of power who will be served by this patient giant who has so long waited to be chained.

And what possibilities in the way of revolution of our industrial and economic methods are shadowed forth by this greatest and most dramatic of all instances of the electric transmission of energy! No engineer needs to be reminded that in electricity we have, not a new "power," but simply a means of transmission, rendering a service analogous to that of shafting, of belting, or of water or air in pipes. But electricity bids fair to permit such transmission of energy to great distances as may in the near future enable us to utilize many sources of energy, besides that of water-falls, which have hitherto been almost if not entirely neglected, such as wind-power and the power of tides, currents, and waves; so that it is scarcely too much to suppose that, if the process goes on with sufficient rapidity, we may not only defer indefinitely the exhaustion of our coal-mines and forests, but leave these, as it were, a drug on the market, in the same category with the stage-coach, packet-ship, and canal-boat.

The starting of the turbines of the Niagara Falls Paper Co., on January 25, may be said to be the first practical application of the power of the falls under the auspices of the Cataract Construction Co. The three turbines, of 1100 horse-power each, were built by R. D. Wood & Co., of Philadelphia, from the designs of their engineer, Mr. Emile Geyelin. They are of the inverted type, in which the water acts upward from below the wheel, so that the weight of the latter serves to counteract the pressure of the 145 feet head under which they work, and thus to diminish the resulting friction.

AN engineering specialty of comparatively recent birth and development is that of what may be called insurance engineering, to which such men as Freeman and Woodbury, of Boston, and Hunking, also from Massachusetts but now of Philadelphia, devote their energies, to the more or less complete exclusion of other matters. The insurance engineer, if we may coin the term, is generally in the service of an association of manufacturers formed for mutual protection against fire, and his study is directed to the determination of those forms of building construction, of storage within buildings, and of fire-extinguishing apparatus, which most effectually prevent the breaking out of fire, or which lead to its speedy and economical extinguishment if once started. And let it not be supposed that this segregation of his activities in a field comparatively limited and somewhat removed from the broad acres of "civil engineering" necessarily deprives the profession at large of his services. The insurance engineer is necessarily a hydraulician, at least, and few more exhaustive and valuable contributions to our stock of knowledge of hydraulics have been made than that embodied in Mr. Freeman's researches into the behavior of fire streams and the flow through nozzles, presented within recent years to the American Society of Civil Engineers.

This branch of engineering, like others, has a literature of its own. We note, for instance, "A Technical Dictionary of Fire Insurance" [1886, 344 p.], and "A Technological Dictionary of Insurance Chemistry" [1890, 407 p.], both by William A. Harris, of the Phœnix Fire Office, London.

LABORING in a nearly related field, the noted French hydraulician, M. H. Bazin, co-laborer with the late and great Darcy, has for years been conducting a most elaborate series of experiments upon the flow of water over the weir, that universally recognized measurer of flow to which hydraulicians of all classes are fain to resort. The experiments are divided into five series, the first two of which are devoted to the investigation of weirs delivering a perfectly detached sheet of water, behind which the air has free access. The first of these two series concerns itself with the determination of the coefficient of flow in vertical weirs, while the second is devoted to the study of inclined weirs and to the investigation of the pressures and velocities within the "nappe," as the falling sheet of water is called. The results of these two series have already been published in the proceedings of the Engineers' Club of Philadelphia. In the third series the distinguished experimenter enters upon the study of cases where the air is prevented from entering behind the nappe. The fourth series will shortly be published in the Annales des Ponts et Chaussées, and the entire work will close with a summary of the results obtained in all the series.

SIR WILLIAM ARROL, having bought the old Hammersmith bridge, at London, intending to use the material for false work at the Forth bridge, found the iron, after sixty-two years of service, as good as new. Pure white lead was at the bottom of the secret. Many of the parts, which were inaccessible, had not been repainted since their erection.

IN more senses than one the question of aerial navigation is "in the air." Its study is no longer confined to a few dreamers, but is eagerly taken up by intelligent and practical engineers, who meet in "world's congresses" to discuss its merits and its latest developments. Early in January a lecture was delivered on this subject before the Franklin Institute, in

Philadelphia. The lecturer was to have been Mr. O. Chanute, the well-known civil engineer, past president of the American Society of Civil Engineers, who has been styled the critical historian of aerial navigation, and whose recent writings form so important a portion of the literature of the subject. Mr. Chanute, however, was prevented by illness from appearing, and his place was taken by Professor A. F. Zahm, of Notre Dame University, Indiana. The lecturer divided the inchoate art of aerial navigation into two broad classes—"aeronautics," or ballooning, and "aviation," or flying, each of which may manifest itself in the "active" or in the "passive" state—and proceeded to review their past and present relations and to attempt a modest glance at the future of the art.

While the aviators or "flyers" (if we may borrow a term from railroad practice) have for a long time been studying the subject, the field of practical operations has, until very recent years, been monopolized by the balloonists; but the last decade, and particularly the last five years, have seen the aviators making wonderful strides, and chiefly in the direction of lightening their motors and machinery, until now they seem nearer than their rivals to the accomplishment of results.

The "passive" balloonists, or those who depend for support upon the buoyancy of their vessels, and for propulsion upon the wind, are compelled to rely chiefly upon the constancy of currents in the upper air, and no less an authority than Professor Hazen assures them that at considerable heights, say above 5000 or 6000 feet, the wind in this vicinity blows steadily from the west.

"Passive" ballooning has rendered good service to meteorology. In France, which, by the way, appears to be the home and nursery of aerial navigation, balloons provided with self-recording apparatus have recently been sent up to altitudes far exceeding any ever reached by aeronauts, and their records have given valuable information respecting the temperature of the upper atmosphere. In one of these experiments it was found that the temperature fell 1° F. for every 165 feet of ascent above the earth's surface, and it was estimated that the absolute zero of temperature (= — 459.4° F.) would be found at a height of a little over sixteen miles. These results are too startling to be accepted without thorough verification, but the experiments are being pushed forward.

"Active" balloonists, like their "passive" brethren, rely upon the buoyancy of gas for their support in the air, but make use of machinery for their propulsion and for steering. The great example of this method of navigation is the French military balloon, "La France," the cigar-shaped vessel 165 feet long, 27.5 feet greatest diameter, with suspended car containing electric motors, which was launched in August, 1884, and which made several trips during that and the next year, proving itself well worthy of the title of the dirigible balloon. It made over fourteen miles per hour. Its designer, Renard, is now at work upon a similar bird-of-war of about double the dimensions of La France. With this greater machine it is believed that it will be possible to travel at the rate of twenty-five miles per hour for twelve consecutive hours.

The "active" aviators propose to lift and support themselves in the air, and to propel themselves through it, by means of machinery in the shape of either flapping wings or of a screw propeller, or of an inclined plane called an aeroplane and urged forward by machinery, preferably of the screw type. The leading experimenters in this line are Maxim, of America, Phillips, of England, and Hargrave, of Australia. Maxim has constructed in England a machine 200 feet long, weighing about 7000 pounds and provided with a compound steam-engine exerting 300 horse-power and capable of carrying 14,000 pounds, including the machine itself.

Phillips's machine is a pigmy in comparison. It weighs but 330 pounds, and its screw, 6 feet in diameter, with 8 feet pitch, exerts a pull of 75 pounds when running 400 revolutions per minute. Its aeroplane, 8 x 22 feet, is formed of slats $1\frac{1}{2}$ inches wide. It has flown 2000 feet, at a speed of forty miles per hour.

Hargrave's machine is propelled by flapping wings instead of screws. These are to be applied to a "cellular kite," consisting of a pair of compound aeroplanes, designed with a special view to the stability of the machine, one of the most important problems confronting the aviator.

Mr. Hargrave has made a large number of models, all of which have flown successfully. His first models were mere paper toys, actuated by gum bands. The machines which he is now constructing are to be propelled by steam power.

Professor Zahm called attention to the following facts, which, he claimed, were amply proved: 1st, that the power required for flight is now found to be much less than was formerly supposed; 2d, that more than the necessary power can be obtained from such motors as the machines can carry; 3d, that a well-designed flying-machine is most efficient at speeds which are impracticable for a balloon; 4th, that at speeds exceeding 25 miles per hour the flying-machine will carry a greater burden than a balloon with the same expenditure of energy, besides being cheaper to house and to repair; 5th, that flying-machines are most efficient when of moderate sizes, whereas balloons, in order to be efficient, must be enormously bulky; 6th, that the flying-machines now actually in sight, when once they have been perfected, may, without stopping for supplies, execute journeys rivalling those of the most powerful birds, both in distance and in speed.

The lecturer concluded his remarks with a brief reference to the efforts of the "passive aviators," who seek to imitate the movements of a bird in soaring when it moves upward through the air with motionless outstretched wings. Herr Lilienthal, of Berlin (a veritable "flying Dutchman"), has been practicing for three years with a pair of wings thirty feet from tip to tip, and weighing forty pounds. Armed with these ponderous pinions, and selecting a hill sloping toward the wind, Herr Lilienthal runs along its top, springs into the air, and coasts downward upon it some sixty or eighty feet.

If this new pursuit of aerial navigation eventually materializes, in which of our established branches of engineering shall it be classed? The "mechanical" and the "electrical" engineer seem to have all the work to do, and the "civil" engineer (the builder of railroads or of waterworks or of canals) practically nothing, although M. Maxim's machine does stand upon and will start from a railway track. Yet aerial navigation hardly belongs either to mechanical or to electrical engineering. It seems rather destined to form a new branch of civil engineering, especially when we reflect that civil engineers are among its foremost disciples in this and in other countries; but if it continues to advance as it has done in the past five years it will have established its independence before it can be fairly classed as a branch.

The serious efforts of the military engineers in the development of the flying art make it appear probable that aerial navigation may come to be regarded as a branch of military engineering, if, indeed, the funeral obsequies of that eminently respectable but practically defunct profession are not performed before the active and interesting embryo is fairly hatched.

At a meeting of the Austrian Society of Engineers and Architects, held November 18, 1893, Professor George Wellner, of the technical high-school at Brünn, laid before a crowded and enthusiastic audience the first publication of his proposed system of aerial navigation, a system which he claims to be absolutely new. The principle which Professor Wellner proposes to employ is perhaps most briefly expressed in the magnificent compound name which he himself has conferred upon the proposed machine: "Segel-radflugmaschine," which in English we can hardly render more concisely than by the expression flying-machine-with-paddle-wheel-sails. To use the inventor's words, his machine is neither more nor less than a mechanical reproduction of the mechanism of a bird's wing, albeit the professor claims, in some respects, to imitate rather the insect than the bird, and especially in this, that many insects can and do readily remain fixed in a given position in the air, whereas birds can accomplish this only by an excessive expenditure of work.

Professor Wellner raises and propels his flying-machine by means of the rotation of large wheels. The axes of these wheels, like those of screw propellers, are either coincident or parallel with that of the vessel and the direction of its forward motion, and in the matter of propulsion the action of the wheels is similar to that of a propeller; but in respect to the raising of the machine and keeping it suspended in the air, they differ radically in their action from the screw, and resemble rather the paddle-wheel, with movable floats, for here the floats are so arranged, by means of eccentrics and eccentric-rods, that when at the uppermost and lowermost points of a revolution they are so inclined that the vertical component of their pressure forces the air downward and the machine upward (*vice versa*, of course, when their action is reversed), and when their arms are in the horizontal position the floats exert no tendency to raise or lower the machine. Propulsion is provided for by so inclining the webs used for bracing the floats that they act as elements in the blade of a screw, and thus drive the machine forward.

Drawings were presented, showing a "twin-screw" application of the device. A machine designed to carry from four to eight persons has two wheels (or more properly cylinders) 21 feet in diameter and 63 feet long, and between and below these is suspended a cigar-shaped car 8 feet in diameter and 40 feet long, carrying the motors, the passengers, etc. Each wheel or cylinder has arms or spokes, arranged in eight radial planes and carrying as many floats. The arms, like the axles, are of steel tubing. Steering is accomplished by means of four rudders, which, by being placed at right angles to the path of the vessel, may, the inventor claims, be used to hold the machine steady, without motion forward or backward.

Such a machine, at 135 revolutions per minute, would exert 30 horse-power, would lift 14,000 pounds and would be capable of traveling from 45 to 90 miles per hour. A machine for two persons would require from 30 to 40 horse-power and would cost from $8000 to $12,000.

A small model, with but one wheel and worked by hand, was exhibited, and was run backward so as to exert a downward pressure in addition to its weight, and this pressure was measured by weighing it upon a scale. The current of air through the machine, downward when the machine was run in the normal direction, and *vice versa*, was illustrated by the convenient means of tobacco smoke.

So enthusiastic were the members present that a resolution was unanimously adopted, requesting the board of directors to suggest ways and means for carrying on these experiments; and at the meeting of December 30 it was announced that a fund of $800 had been subscribed and placed at the disposal of a committee appointed to prosecute the work.

The inventor says "these are not empty phantoms—not hazy picturings of the desires or airy machinations, that I am pursuing. I stand upon solid ground. I move forward, step by step, upon a mechanically constructive basis. My whole nature revolts from the phantastic."

THE lay mind finds itself asking what must be the effect of wind velocity upon the practical efficiency of the air-ship or flying-machine, supposing it constructed. A machine that could make 30 miles per hour in a calm, while it would make double that velocity in a 30-mile gale in the same direction, would make no progress at all against a head-wind of the same velocity and would be driven backward 10 miles per hour by a 40-mile head-wind. And even supposing a machine constructed with a speed greater than that of any which it may have to encounter, the enormous differences between its rates of travel with and against the wind must at least militate seriously against the regularity of its traffic.

MINING & METALLURGY

Conducted by Albert Williams, Jr.

REFERRING to the problem of the best method of developing a comparatively flat-dipping lode (say 30°, or a little more, from the horizontal) after the lode has been originally opened by a vertical shaft, a correspondent makes a practical suggestion that may be of value to the many mine managers who are confronted with the same difficulty. As to the old controversy of vertical shaft versus incline, other things being nearly equal, the weight of opinion and experience is, we believe, strongly in favor of the former. As our correspondent says, the argument is all one way. The best practice, in this country at least, always adopts the vertical hoist for important operations, unless adits of reasonable length are, from the lay of the ground, feasible, or unless the dip of the lode or vein carries it into a steep hillside, causing a site for a vertical shaft to be disadvantageously placed. Or, where the amount of water to be handled is unusually heavy, it is considered permissible to run adit tunnels of a length that would otherwise be prohibitory. It is true that there are many mines in the United States, just as there are in the older European districts, which were originally opened by inclines on the dip, because of following down pay ore or coal from the surface and because of lack of means to change the system by erecting proper machinery in a new plant over a vertical shaft, so that an unsatisfactory method has been persevered in perforce. But the case in point is that of an important mine opened by vertical shaft, the shaft having passed through the lode and in its descent rapidly increasing the distance to be cross-cut and trammed over, each successive level being longer than the one above it, until the tramming expense becomes inordinate. It is assumed that the ground above and near the point of intersection of lode and shaft has been worked out. The case referred to by our correspondent is a concrete example,—that of a real mine, and one which is quite common. Sometimes it is met by changing the vertical shaft into an incline on the lode, an awkward arrangement as usually devised. The plan suggested by our correspondent is to follow the shaft by an incline, but to cut a pocket underground at the angle point or elbow, into which the skip coming up the incline may dump its rock automatically. From this pocket chutes would lead to and feed the cars to be placed on the cages running in the vertical shaft. In this way there would be no great waste of time or money. A sketch of the proposed arrangement shows a very simple and practicable plan—much better than that of turning the angles on wheels. However, at best the problem is always a puzzling one, and has to be solved independently in each instance, the solution depending upon a variety of considerations which cannot be discussed here, the principal perhaps being the extent and relation of the previous workings.

THE American Iron and Steel Association reports the total make of pig-iron in the United States in 1893 at 7,124,502 long tons, as against 9,157,000 tons in 1892, 8,279,870 tons in 1891, and 9,202,703 tons in 1890. The decrease in 1893 from 1892 was over 22 per cent., the falling off occurring wholly in the second half of the year, the production in the first six months having been larger than in the last half of 1892. Twenty-three States contributed to the total, Pennsylvania leading, with Ohio second, Alabama third, and Illinois fourth. The total number of furnaces in blast at the close of 1893 was 137, with

381 out, or about half as many in blast as at the close of the preceding year. These figures will give some idea of the depression in the iron trade. Since the end of the last calendar year the situation has brightened somewhat, but it is now anything but satisfactory. According to the kind of fuel used, the classification of the pig-iron product in 1893 was: anthracite, 1,347,529 tons; charcoal, 386,789 tons; bituminous, 5,390,184 tons. Of this total, 3,568,598 tons were of the Bessemer grade.

THE *Bulletin of the American Iron and Steel Association* publishes full returns of the production of Bessemer steel ingots, and, with a small exception, of Bessemer steel rails of all weights and sections in the United States in 1893. Under "ingots" are included the products of the few Clapp-Griffiths and Robert Bessemer plants and steel castings, the total being 3,123,524 long tons, against 4,168,485 tons in 1892. The productions of Bessemer steel rails in 1893 was the smallest since 1885, being only 1,036,353 tons.

IN the latest annual report of the secretary of the navy of the United States it is stated that the armor-plate tests last year have in cases exceeded in severity any ever attempted either in the United States or elsewhere; while the results have conclusively demonstrated the desirability of using the Harvey process for the armor of all ships now under construction. The development of nickel-steel armor and the Harvey process were fully described by Mr. R. B. Dashiell in THE ENGINEERING MAGAZINE for September, 1893. The experiments made induced the secretary to order that all the armor already contracted for, and not too far advanced, should be "Harveyized." The report also refers to the noteworthy success of American steel-makers in producing armor-piercing projectiles, and it is said that they are equal, if not superior, to any made abroad.

THE German pig-iron industry, like that of the United States and Great Britain, has suffered in the general business depression. The output for 1893 is estimated at about 4,700,000 metric tons. The decrease from the production of 1892 was not large—about 7000 tons—but prices were much lower, owing to the slackened demand for finished iron and steel.

THE *American Slate Trade Journal* figures the production of slate in the United States in 1893 at $3.578,000 worth, of which $2,780,600 worth was roofing slate. The number of quarries reported is 202, situated in Pennsylvania, New York, Vermont, Maine, and Virginia. In point of quantity the production showed little decrease from 1892, but prices were much lower.

ACCORDING to provisional estimates of the *Engineering and Mining Journal*, the production of zinc in the United States in 1893 was about 74,500 tons (of 2000 lbs.), against 83,619 in 1892.

The same authority states that the output of copper from domestic ores in 1893 exceeded somewhat the production in 1892 (which was reported in the "Mineral Industry" at 325,180 long tons and in "Mineral Resources" at 344,998,679 long tons). The Calumet & Hecla mine, of Michigan, considerably increased its output; while the Anaconda, of Montana, curtailed operations on account of low prices.

The production of lead in the United States in 1893, again quoting from the *Journal's* estimate, was about 150,000 short tons from domestic ores and 58,000 tons from foreign ore and base bullion. The falling off as compared with the production in the preceding year occurred wholly in domestic silver-bearing lead.

NEVADA has fallen behind wofully in the production of the precious metals since the bonanza times. The report of the State controller for the year ending September 30, 1893, just issued, gives the value of the bullion product of that period at only $2,501,169. For the calendar year 1893 the Virginia City *Enterprise* estimates the total for the State at $3,000,-000, of which about $800,000 only is credited to the Comstock lode. This would have been thought a poor showing for one month in the old days.

It is not generally known that anthracite is mined to a limited extent in the Rocky mountain region. The beds, it is true, are not comparable to those of Pennsylvania, either in size or quality, being locally altered deposits of bituminous coal metamorphosed by the heat of intrusive dikes. A recent discovery of a new deposit has been made near Ouray, Colorado. In 1892 the anthracite product of that State was 62,303 tons, all from Gunnison county.

The annual report of Wells, Fargo & Co., showing the precious metals produced in 1893 in the States and Territories west of the Missouri river (including $263,968 gold from British Columbia) gives the aggregate production as follows: Gold, $34,202,691; silver, $38,491,521; copper, $23,631,339; lead, $7,756,640; gross result, $104,081,591. The several metals mentioned have been estimated at the following commercial values: Silver, 74 cents per ounce; copper, 10 cents per pound; lead, $3.50 per hundred. Mr. Valentine, president of the company, who collected the statistics, explains that allowance must be made for probable variations from exact figures, by reason of constantly increasing facilities or transporting bullion, ores, and base metals from the mines outside of the express and the difficulty of getting entirely reliable data from private sources. Estimates obtained in this way are liable to be exaggerated.

In a report of the Pennsylvania coal-waste commission it is stated that the amount of waste is estimated at 317,000,000 tons, representing a money value of about $600,000,000. The president of the Scranton board of trade adds: "We are increasing the amount of waste annually by a volume of 2,000,000 tons, an aggregate of natural substance going to waste unheard of and unparalleled. The culm above ground and the annual increase, if reduced to a gas equivalent, would make a total of 200,000,000,000 cubic feet of gas." He further says "the contemplation of the gas subject in the anthracite coal fields is almost like an Aladdin story." After careful and exhaustive calculation, he figures out that this gas could be produced for less than 2 cents per thousand cubic feet, and he emphasizes this conclusion by adding: "Incredible as these figures may seem, they are certainly approximately true, and will undoubtedly in time be fully verified." Some successful experiments have been made lately in producing a gas from anthracite coal, differing from former water-gas projects. Besides this possible utilization, there is a promising system of burning the culm under boilers in furnaces of special design, already mentioned in these columns. The manufacture of briquettes does not appear to be increasing rapidly, though there is at least one make that is finding a fair market.

As was to have been expected, a very determined effort has been made by representatives of the coal-mining interests against the adoption of the free bituminous coal clause of the new Wilson tariff bill, which has passed the house and at the date of writing remains to be acted on by the senate. Unquestionably the removal of the present duty (75 cents a ton) would for a time at least adversely affect the coal-producers, especially in Pennsylvania, Maryland, Virginia, West Virginia and Washington. It would, on the other hand, benefit the manufacturers on the seaboard, particularly in New England (where soft coal is not mined and only a little poor anthracite), who would then draw upon Nova Scotia and perhaps England, the foreign coal coming in at low freight rates and occasionally as ballast. Along the great lakes a reciprocal arrangement with Canada would tend to equalize matters. On the Pacific coast British Columbia would become a stronger competitor with Washington for the California and Oregon trade, and imports from New South Wales to San Francisco might be increased. A little Mexican coal would probably reach

Arizona. In the interior a removal of the duty would not greatly alter the present condition for consumers, who would continue to draw upon the nearest coal-fields. There is no general monopoly of the bituminous-coal trade, the sources being too numerous and diverse. In brief, the price of bituminous coal depends on three main factors: the cost of mining (mainly wages), freights, and (along the seaboard and by sympathy to a certain extent inland) the effect of an import duty. To these items might be added the royalty, where the operator does not own the ground worked. On the principle of putting all raw materials on the free list it is only consistent that bituminous coal should be so classed; yet, while it cannot be denied that many consumers would be benefited, the change seriously threatens the coal-mining industry wherever the difference in cost of transportation in favor of domestic fuel will not outweigh the cheaper production of foreign coals.

IMPORTED lead-ores, in the schedule of the Wilson tariff bill, are to be subject to a duty of 15 per cent. ad valorem, unless the value of the silver contents exceeds that of the lead, in which latter case they are to be admitted free. This item has been for years the bone of bitter contention between the interests involved. The clause bears almost wholly upon imports of silver-lead ores from Mexico, little coming into the United States from other sources. The smelters favorably situated for taking the Mexican ores naturally favor low duty or free imports; those at a distance do not. Miners of lead and silver-lead ores in the United States of course desire a protective tariff; while some miners of dry ores requiring lead-ores for the smelting mixture would be benefited by cheap lead ores. Hence the tariff question in this instance is a purely local issue. Lead-ore is certainly one of the rawest of raw materials.

MR. J. S. JEANS, the leading English authority on the subject, in a paper recently read before the British Iron and Trade Association, makes a frank acknowledgment of the supremacy of the United States in iron- and steel-manufacture. The statistics quoted are very striking, and in discussing them Mr. Jeans points out that not only has Great Britain lost its supremacy as the iron-manufacturer of the world, and as the first producer of steel and as the manufacturer of the products of rolling-mills and forges dealing with malleable iron, and as a maker of pig-iron, but, finally, as the principal iron-ore producing country of the world. If, however, the author had laid more stress on the respective exports of iron and steel, a better relative showing could be made for the older country. In the United States it is mainly the immense demand for home consumption caused by the necessities of rapid development, as in railways and machinery, that has brought this great industry to the fore, while thus far we have only made a beginning as a competitor in the world's markets.

AN important strike of lead-ore is reported at Galena, Illinois, in a mine that had been abandoned by an Eastern syndicate which formerly operated it. The find was made by two miners who had faith in the property and persevered in prospecting it. At present prices for lead only exceptionally rich deposits pay for working.

OF forty applications by hydraulic miners in California to be allowed to resume work, made up to the close of January, twenty-four were passed upon favorably by the débris commission and others await further action. It is evident that when impounding works to retain the tailings shall have been constructed in accordance with the plans, a considerable number of hydraulic mines will be placed again upon the active list, thus adding materially to the gold output of California, so long restricted by adverse legislation and judicial decisions.

IN a recent paper on "The Chemist in Foundry Practice" Mr. H. O. Chute, after explaining the causes which led to the divorce of the foundry from the iron-furnace, discusses the problems which the founder is called upon to solve, and shows how under intelligent technical management tedious and costly experimentation with the cupola may be supplanted by the knowledge derived from chemical analysis. Mr. Chute takes, for example, the case of a cupola mix of six or more irons, containing six varying proportions of six elements, the question being to produce a definite result, and very justly says that the number of combinations which may be made before the right one is found offers a very interesting field for the calculation of the mathematician, but that their contemplation often wearies the founder. Here an analysis of the casting locates the cause of the trouble, if any, and a knowledge of the composition of the irons in the mix enables the offender to be singled out and points the remedy at the same time. Heretofore, Mr. Chute says, the majority of founders have considered that the extent of their business did not warrant the employment of the services of a chemist. The Foundrymen's Association, however, offers an opportunity for mutual aid in this direction by having a laboratory for their special use, where they could always consult with a specialist on the problems constantly arising. The improvement of quality and cheapening of product, with greater precision in method, are the points aimed at, and progressive founders appreciate the extent to which their art will be indebted to chemical knowledge. In this they are merely falling in line with other similar industries, which have found it poor policy to rely upon empiric methods when a scientific treatment is within reach.

One of the disadvantages of the ordinary beehive coke-oven is the difficulty of getting sufficient heat to the bottom of the charge. The lower stratum of coal is either undercoked and the product has to be sold as an inferior grade of coke, or the top of the charge is overburned, causing waste. An improvement which is said to give excellent results is the addition of a horizontal flue from the trunnel head connected with a vertical joint outside the oven and leading down to a series of other horizontal flues at the bottom of the oven by which the hot gases are circulated under the charge and thence out. The effect is reported to be a more uniform grade of coke with a saving in time and of some material.

Iron-ore is mined in thirteen departments in France, the total number of mines or workings in activity being about sixty. The total production of iron-ore of all kinds is about 2,500,000 tons a year, the average value of which at the place of production is given at 3½ francs.

Recent experiments in utilizing peat for gas-making have not given satisfactory results; but it is stated that the peat tried was not of the best quality. Any method by which it could be profitably employed on a larger scale would open a practically new industry, the resources for which are enormous in many parts of the world where better fuel is not available.

An investigation into the gases "inclosed" in coal dust has been made and described by Dr. T. P. Bedson before the British Association. The conclusions reached are that the denser hydrocarbons are more firmly held by the coal substance than the lighter marsh-gas; and that in the working of the coal the reduction to a fine powder, such as coal dust, must, by free exposure to the air, allow ample opportunity for a ready diffusion of the marsh-gas, the denser hydrocarbons being retained by particles of coal.

An ancient but apparently still successful trick for entrapping the unwary into buying worthless mining stock is to give the latter a name so closely resembling that of some paying and reputable mine that only those who are well informed can tell the difference. This small, mean fraud has been exposed about as often and publicly as the bunco and sawdust games, bnt like these it continues to work. There are always plenty of gudgeons ready to bite at the most palpable shams. During the Leadville excitement a whole flock of stock companies were floated having names closely imitating that of the one *mine* deriving its name from that of the district, but varying from it by slight additions or word twists. Now in a new western gold-mining district there is a mine which has made a creditable record for itself by paying small dividends continuously for many months. Its fame has, after the old fashion, been traded upon by another company which has adopted its title, adding the word "consolidated" as a saving distinction — which, however would escape the notice of any one not familiar with the two properties. In this case a strange, but not unprecedented, accident has occurred. Originally started purely as a stock-selling scheme, the promoters now find themselves in the unexpected position of having a mine on their hands, having really struck ore, so at least it is reported. It would be a curious bit of unpoetic justice if the second property turned out bigger than its namesake, for then its sponsors would feel like kicking themselves for not having adopted a distinctive name of their own. This game of appropriating names of well-known mines has been carried to such an extent that the share certificates have sometimes been printed in close imitation of more valuable stock, the slight differences in title being to all appearance suppressed by being put in letters so small as not to attract notice. A parallel device for misleading innocent investors of small means and less knowledge about mining is to confound common with treasury stock, advertising quotations of the one as for both kinds, whereas there might be all the difference between the two that exists between something and nothing.

A NEW electric safety-lamp, known as the Gauzantes and named after the French electrician, its inventor, is claimed to surpass all previous types of electric safety-lamps in point of small size and lightness. It is thus described by an English journal: "In size the lamp is four inches wide, two inches broad and about eight inches high. Its weight, when fully charged is about three pounds and twelve ounces, and it gives a light of three-fourths candle power. The first cost of construction is only $1.25, and the weekly cost of replenishing the battery is only eleven cents, whilst so little wear and tear do the internal parts undergo that the life of the lamp is reckoned to be five years. The metal which serves as the anode of energy is refined by a new and simple process, and allows a maximum generation of current without fear of rapid polarization, which has up to the present time proved the great obstacle to the employment of the direct source of electricity. The fluid which serves as exciter is a new combination, giving in a single liquid all the properties necessary for the production of a regular and constant current, not only from a dynamic point of view, but also in the reabsorption of the sulphates thereby produced. The new fluid can be manipulated without danger in either preparation or use. The lamp has been tested in Belgium, and the opinion of the introducers was distinctly that the lamp was a good one."

Another improvement in safety-lamps is a modification applicable to the "J. C. N.," Marsaut, or Muessler patterns, enabling them to use with safety, it is said, kerosene or other cheap mineral oil. The attachment is designed to prevent the flame spreading down the wick into the oil-well, where the trimmer works, and includes a nickel-plated reflector for increasing the illuminating power.

FROM time to time the record for deep boring is broken, and now, according to the *Revue Scientifique*, it is held by a bore-hole at Parvschowitz, in western Silesia. The depth is 6568 feet, at which point work has been temporarily suspended, but it is hoped to attain a final depth of 8200 feet. The bore is only 2¾ inches in diameter, as reported, though it is to be presumed that this figure relates to the lower portion only, it being customary in sinking very deep borings to begin with a large diameter, using smaller and smaller bits as the work goes down. It will be noticed that if such a boring were to be started at the bottom of a mine 4000 feet deep, a total depth of over two miles could be explored.

CURRENT TECHNICAL LITERATURE

Conducted by Nelson W. Perry, E. M.

A STANDARD DICTIONARY OF THE ENGLISH LANGUAGE, Prepared by more than Two Hundred Specialists and Other Scholars, Under the Supervision of Isaac K. Funk, D.D. Francis A. March, LL.D., L.H.D., and Daniel S. Gregory, D.D., Editors, and Arthur E. Bostwick, Ph.D., John Denison Champlin, M.A., and Rossiter Johnson, Ph.D., LL.D., Associate Editors. In two volumes. Vol. I—A to L. New York: Funk & Wagnalls Co. [Half Russia. 4to. xx-1060 p. $7.50.]

OF the making of dictionaries there is apparently no end, and indeed it may well be so, since surely a completed language is like a finished city, ready to take its place among the dead, and the activity among the dictionary-makers may be as true an indication of strength and life as is the busy disorder of the growing city in its prime.

It has sometimes been questioned whether there is advantage or detriment in the establishment of an official repository of a language, such as the French Academy, and while we have as yet no such monument as the great work of Littré, the absence of competition has certainly acted to limit the production of such popular and valuable works as the one before us to countries in which any publisher may enter the field, confident that his product must stand or fall on its own merits, without either the help or hindrance of government authority.

To review the work as a whole would be both foreign to the scope of this Magazine and impossible in moderate limits of space, but the sub-title of the Funk & Wagnalls "Standard Dictionary" invites special attention to technical terms, since it is claimed that the work is "designed to give, in complete and accurate statement, in the light of the most recent advances of knowledge, the meaning, orthography, pronunciation, and etymology of all the words and the idiomatic phrases in the speech and literature of the English-speaking peoples."

It is especially gratifying to find that the claims included in this very broad scheme have, on the whole, been fairly well substantiated; for a good, technical dictionary, giving in popular as well as accurate statement the correct meaning of technical terms, has heretofore been sadly lacking, even those which make no claim to include the whole language often failing to give the correct definitions of many terms in the specialty which they profess to cover. To find, then, a general dictionary of the English language in which all the technical terms have been defined by specialists is indeed encouraging, and the popular form in which the work has been done is a strong tribute to the growing interest of the entire people in scientific subjects.

The method adopted combines that of the dictionary with that of the encyclopedia, illustrations being freely used and usually with the scale of reduction given. The value of illustrations appears to great advantage in the case of mechanical subjects, as is perhaps best shown in the subject "Locomotive," under which a line drawing of a "Class O" locomotive engine of the Pennsylvania railroad is given, with nearly a hundred reference lines, giving immediate and accurate information of the various parts. A similar illustration is given to "Lathe," although the drawing is hardly so good, while "Engine" is shown by a small cut, which at least serves the purpose of making the definitions intelligible. These and similar subjects are given very full treatment, the definitions being in many cases accompanied by a brief explanatory text, forming practically a short encyclopedia article, thus greatly increasing the value of the book, especially to non-professional users.

Among the titles which are treated with especial fullness may be mentioned architecture, carpentry, cement, clay, cotton, color, coin, engine, explosive, foundry, gun, knot, lathe, lock and locomotive. As this first volume only includes titles from A to L, inclusive, many cross-references cannot be compared, but doubtless the second volume will correspond closely in every way with the first.

Among the definitions some exceptions must be taken, and it is especially unfortunate to find among these one which cannot but prolong the task which accurate writers upon mechanical subjects have so long been endeavoring to complete: the removal of the existing confusion in the use of the fundamental terms of mechanics. There are few more common errors, in both popular and practical usage, than the misuse of the term "force" as synonymous with "power," and indeed it is to a misconception of just these terms that so many fallacious attempts are made by half-educated mechanics to produce devices which shall in some mechanical way result in a gain of "power." From the inventor of the latest perpetual motion down to the man who has hit upon a "power-gaining device" which shall make the bicycle "wheels go round" faster up heavy grades without the expenditure of more "force," we find abundant examples of the need of more accurate understanding of the true meaning of these terms.

Turning now to the word "Force," we find it most correctly defined as "any cause that produces, stops, changes, or tends to produce, stop, or change the motion of a body," this being practically Tait's admirable definition. But, unfornately, this is immediately followed in the same sentence by "*mechanical power* as exerted in pulling, pushing, pressing, attracting, or repelling," thus clearly defining *force* as *mechanical power*, and this error is only partially retrieved by the subsequent explanation that force "may be measured in pounds or other units of weight." In the absence of the definition of the term "Power" it is impossible to compare the two definitions, but, turning to "Energy," we find it most tersely defined as "power in active exercise; force in operation," than which nothing better could be desired. In the explanatory text accompanying the definition of "Force," after a clear discussion of the relations of "force" and "energy," the statement is correctly made that "the *energy* possessed by a body is quite another thing from the *force* exerted on it or by it," and yet it is difficult to see the difference between "mechanical power as exerted in pulling, pushing, etc.," and "power in active exercise." Clearly the use of the term "mechanical power" in the definition of force is objectionable and unfortunate.

The definition of "Kinematics" as "a branch of mechanics" is also unfortunate, especially in view of the fact that in the only treatise on the subject worthy of the name, that of Reuleaux, an especial effort is made to show that the subject does not belong to mechanics, its definition being given as "the science of pure mechanism," —also "the science of controlled motion," quite a different thing.

It is gratifying to find the term "Knot," in nautical usage, clearly distinguished from a nautical mile, and this latter use of the term stated to be limited to "landsmen." The only sense in which a knot can properly be conceived as an absolute length is as the distance on the log-line between two consecutive knots or marks, the term knot being properly a *rate of speed* rather than a distance, and always to be used in connection with the element of time.

Under the title "Lock" the term "time-lock" ought to be found, and "combination-lock" given its primary definition as a permutation-lock, instead of giving this place to the combination of two locks acting upon one bolt. The definition of "combination lock" as a "permutation lock," when no definition of the latter term is given at all, is hardly productive of much information to one who is not already informed, and the definition of "Janus-faced lock" as "one in which the key may enter on either side" is altogether too broad, as it would thus include nearly every kind of room-door lock. A "Janus-faced lock" is a form of rim-lock of which both sides of the case are made exactly alike, so that it can be applied to either right- or left-hand doors without change.

Notwithstanding the above points in which greater accuracy should have been given in the definitions, the work is to be regarded as a most valuable addition to the standard list of reference books which every working library should possess, and the fact that, with the one exception above noted, the only points for adverse criticism are of minor importance, is evidence of the fact that the Standard Dictionary is a mine of valuable material, not only in general literature but also in the remote details of special technology.

HENRY HARRISON SUPLEE.

INVENTIONS, RESEARCHES, AND WRITINGS OF NIKOLA Tesla, with Special Reference to his Work in Polyphase Currents and High Potential Lighting. By Thomas Commerford Martin, Editor *The Electrical Engineer;* Past President American Institute Electrical Engineers. Portrait of Mr. Tesla and numerous other illustrations. New York: *The Electrical Engineer*. [Cloth. 8vo. 496 p. $4.]

NIKOLA TESLA'S fame among the electricians and the laity alike has been almost unparalleled, and he and his work have been the subject of more newspaper comment during the past two or three years than is usual even with men who among their confreres have stood equally high. There has been a charm about his experiments with high frequencies and potentials, looking towards the accomplishment of the ideal light without heat that has captivated the laity and thrown into the shade in their estimation his equally important and more practical work with which electricians have been long familiar. Nor have his experiments with the high potentials and frequencies been less interesting to electricians, for they saw in them new avenues of investigation leading no one could or can tell where, but in all probability to results of the grandest import, if pursued to their legitimate end.

Mr. Tesla first called public attention to his experiments with alternate currents of very high frequency and their application to methods of artificial illumination in a lecture before the American Institute of Electrical Engineers at Columbia College, on May 20, 1891. These attracted such wide attention among scientific men abroad that he was induced to repeat the lecture with amplifications in London on February 3, 1892. His reception in London by the leading physicists of England was an ovation such as had never before been accorded to a scientific man.

A third lecture, delivered in abstract before the Franklin Institute of Philadelphia last spring, and in full a few days later before the National Electric Light Convention at St. Louis, completes his own expositions of his discoveries in this line, and a fourth lecture, delivered before a limited number of invited guests, including many of the leading savants of the world, during the International Electrical Congress at Chicago, may be said to complete the list of his appearances before public audiences. The last lecture, which was on the subject of mechanical and electrical oscillators—a subject entirely distinct from the other three—was never reported in full, but is given in Mr. Martin's book in substance. The other three lectures are given at length, with ample illustrations.

But while Mr. Tesla has not appeared much in public, he has been an indefatigable worker along original lines. The descriptions of his discoveries have from time to time appeared in print, but they have become so scattered as to render their collection into convenient shape very difficult, and this is a part of the task which the author has assumed.

Then, again, there is much of Mr. Tesla's work that has been so misunderstood as to lead to confusion among those who have tried to follow him. To explain this work in simple language that even the layman might understand was the remaining and greater part of the task which Mr. Martin undertook, and which he has fulfilled in a most admirable manner.

The work is divided primarily into four parts, and these again into chapters. Part I is introduced by a chapter which is chiefly biographical, and then follow twenty-three chapters devoted to polyphase currents and their applications. Part II is devoted to the Tesla effects with high frequencies and high potential currents. In this are given verbatim the New York lecture (53 pages), the London lecture (96 pages), and the Philadelphia and St. Louis lecture (80 pages). Part III is devoted to miscellaneous inventious and writings and Part IV, in the form of an appendix, describes in two chapters Mr. Tesla's personal exhibit at the World's Fair and the Tesla mechanical and electrical oscillators which were the subject of his World's Fair lecture.

The work is one that will be welcomed by those who are attempting to keep abreast of advanced thought and research, no less than by those who from a non-professional point of view take an intelligent interest in the advancement of science.

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ELECTRIC WAVES, BEING RESEARCHES ON THE PROPAGATION of Electric Action with Finite Velocity through Space. By Dr. Herrick Hertz, Professor of Physics in the University of Bonn. Authorized English Translation by D. E. Jones, B. Sc, with a Preface by Lord Kelvin, LL.D, D.C.L. New York: Macmillan. [Cloth. 8vo. 278 p.]

THIS work, which for the first time brings together the numerous papers published by Dr. Hertz in "Wiedemann's Annalen" on the subject of his magnificent experimental researches in demonstration of Maxwell's electro-magnetic theory of light, is a most welcome addition to electrical literature. The translator, in explanation of the appearance of this work, says that "the publishers of 'Wiedemann's Annalen,' being unable to comply with the numerous applications made for copies of Professor Hertz's researches, invited him to prepare his papers for publication in a collected form. To recast or thoroughly revise them would have been a serious undertaking, and researches are most easily understood when described from the standpoint from which they are undertaken. It was therefore felt best to reprint the separate papers in the form in which they were originally published; but Professor Hertz fortunately decided to supplement the papers by explanatory notes, and to write an introduction, in which he describes the manner in which the investigations were undertaken, and also describes their bearing upon electrical theory and the criticisms to which they have been subjected. The collected researches were published early last year [1892] under the title '*Untersuchungen liber die Aüsbreitung der Electrischen Kraft.*' The book now presented to the English reader is a translation of the German original, with only one or two slight alterations in the notes, and a change, suggested by Lord Kelvin, in the title. I would scarcely have undertaken the translation if I had not been able to rely upon the supervision and kind assistance which Professor Hertz has most freely given, and for which my heartiest thanks are due. I have had the advantage of revising the proofs with him in Bonn, and now trust that no serious error will have escaped notice."

Professor M. I. Pieperi, in an admirable series of articles published in *The Electrical World*, inspired by the recent death of Professor Hertz, estimates his place in botany and the part he played in the development of science so happily that we feel constrained to quote. After having referred to the conflict which existed prior to Faraday between the idea of direct action at a distance, which at that time was the prevailing hypothesis, and the idea of a transferance of action by means of a continuous medium, he says that the latter theory only seemed to introduce additional difficulties into the mathematical analysis of electrical phenomena without offering any reward for this additional labor. "Necessarily so, because experimental science at that time had no wealth to offer for this additional exertion, and it had no simple, plausible theory to substitute in place of the 'direct action at a distance hypothesis.' *It was Faraday who added this wealth and made some vague promises of the reward; it was Maxwell who first discovered the hidden treasures of this wealth, and in most glowing colors described the reward that we would gain by abandoning our old scientific faith in the 'direct action at a distance hypothesis'* and embracing the new faith of Faraday, *and it was Hertz who first convinced us all that Faraday's and Maxwell's promises, though apparently too good to be true, were even more than true.*'

In the case of all great achievements it is interesting to trace back to the germ that gave rise to such great results. Professor Hertz has saved us the trouble of threading this labyrinth by stating in his introduction what he regards as the starting-point of his special work in this line. In commenting upon this, Lord Kelvin says in his preface: "It is interesting to know, as Hertz explains in his introduction—and it is very important in respect to the experimental demonstration of magnetic waves to which he was led—that he began his electric researches in a problem happily put before him thirteen years ago by Professor von Helmholtz, of which the object was to find by experiment some relation between electro-magnetic forces and dielectric polarization of insulators, without, in the first place, any idea of discovering a progressive propagation of those forces through space."

It will be pleasing to Americans to note that Lord Kelvin, as Professor Oliver Lodge had done before him, gives credit to Joseph Henry for having more nearly approached an experimental demonstration of electro-magnetic waves than any one before him.

In conclusion Lord Kelvin says: "During the fifty-six years which have passed since Faraday first offended physical mathematicians with his curved lines of force, many workers and many thinkers have helped to build up the nineteenth-century school of *plenum*, one ether for light, heat, electricity, magnetism; and the German and English volumes containing Hertz's electrical papers, given to the world in the last decade of the century, will be a permanent monument of the splendid consummation now realized."

The character of the book has already been sufficiently described as a reprint, with some additions by Professor Hertz, of his various papers in the order in which they appeared in "Wiedemann's Annalen." It is well gotten up, with many illustrations, principally diagrammatic, which help out the descriptive portions of the text. But it has no vestige of an index other than an index to names, nor has it even a table of contents. It is unfortunate that these essentials to a book's usefulness should have been entirely neglected.

Helical Gears: A Practical Treatise. By a Foreman Pattern-maker, author of Lockwood's Dictionary of Mechanical Engineering Terms. Illustrated. New York: Macmillan & Co. [Cloth. 123 p. $2.]

The design of helical gears is a subject of the greatest importance to the engineer, and yet, strange to say, it is one that has been very much neglected. We are inclined to believe with the author that a very large proportion (he says 50 per cent.) of the so-called helical gears are made quite incorrectly. He begins with Dr. Hook's gear, invented in 1674, as an illustration of the transitional form from the ordinary to the helical gears, and then by logical and graphical methods leads the reader up to the true helical gear, based on its fundamental relationships with the true screw or helical. This little book, which forms one of the Specialists' Series, is intended as a text-book for students in technical schools and should, we think, find favor and usefulness in that field. The author's diction is singularly clear and free from involved descriptions, and is practical rather than theoretical. The illustrations, however, are not first-rate. In the development by graphical methods of such complicated forms as are here dealt with the multiplication of lines becomes necessarily very great, and any cheapening of the processes of illustration is to be deplored, as adding unnecessarily to the difficulties of the student in following the text.

The Tinsmiths' Pattern Manual. Patterns for Tinsmiths' Work. By Joe K. Little, C. E. Chicago: *American Artisan* Press. [Cloth. 8vo. 237 p.]

This is an attempt in an elementary way to supplant the empirical rules for developing tin and other sheet-metal forms usual among artisans by more general geometrical principles. We fear, however, that the author has dipped too deeply into descriptive geometry for the audience for which he writes.

Factory and industrial management