The Wisconsin engineer. Vol. 8, No. 2 February 1904

Madison, Wisconsin: Wisconsin Engineering Journal Association, [s.d.]

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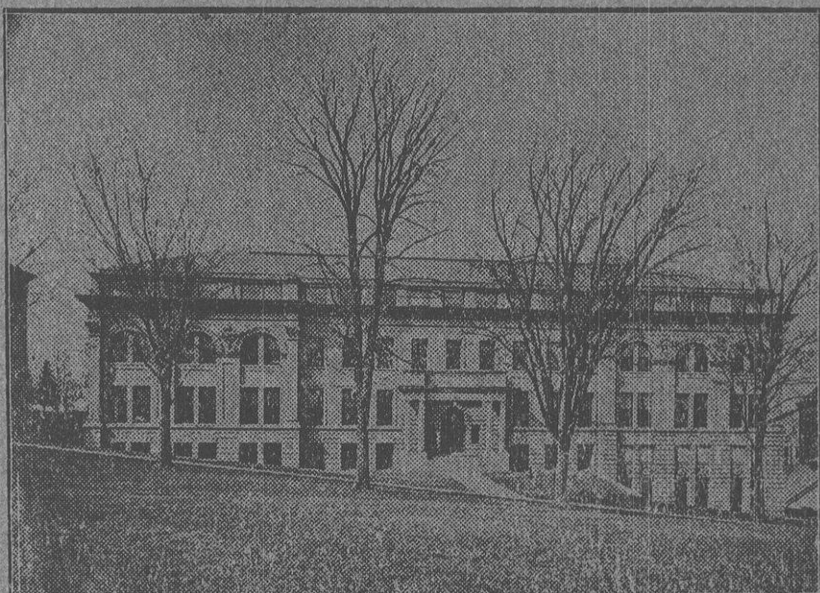
THE WISCONSIN ENGINEER

Vol. 8 FEBRUARY, 1904 No. 2



Published Four Times a Year by the University of Wisconsin Engineering Journal Association

MADISON, WISCONSIN

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Entered in the postoffice at Madison as matter of the second class.

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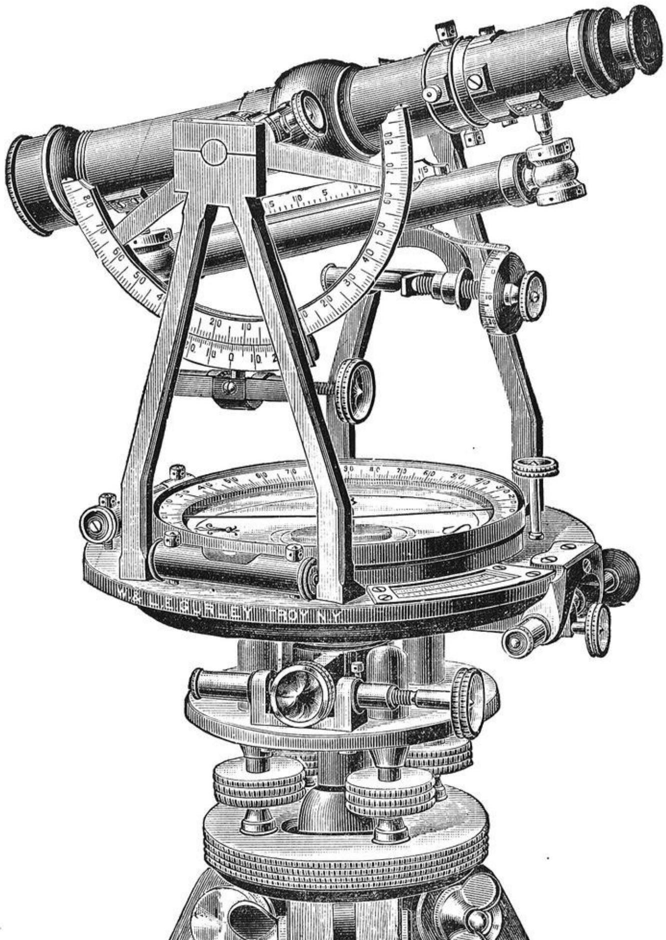

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Dean Frederick Eugene Turneaure.

THE WISCONSIN ENGINEER

VOL. 8 FEBRUARY, 1904 NO. 2

DEAN FREDERICK EUGENE TURNEAURE.

Professor F. E. Turneause who has served as Acting Dean of the College of Engineering since the death of Dean Johnson in June 1902, was elected Dean of this College at the winter meeting of the Board of Regents on January nineteenth.

Frederick Eugene Turneaure was born July 30, 1866, on a farm near Freeport, Illinois, and his early life was that of the average farmer boy. He a ttended the country schools, and while there took up the study of Algebra and Geometry in addition to the studies usually offered in the country school.

He attended the Freeport, Illinois, high school a portion of two years, during the sessions of '82 to '84 and as far as attendance at school is concerned, this completed his preparatory training. He taught in a country school one winter, and by the fall of 1885 he was ready to enter college. Having decided on the profession of Civil Engineering as his life work, he took the entrance examinations and was registered as a student in the College of Civil Engineering of Cornell University.

This was soon after the establishment of certain undergraduate scholarships which were awarded annually by competitive examination, for proficiency in the mathematics required for entrance. The mathematical study which he had begun in the country schools and continued during one year of high school, and later bys elf help, enabled the then freshman Turneaure to win this scholarship, which paid two hundred dollars per year during his entire college course.

He graduated from Cornell with the degree of C. E. in the class of 1889, and immediately entered the service of the

Lehigh Valley Railroad. He remained with this company for about a year, being engaged in general railway engineering work, and then joined the engineering staff of the Chesepeake and Ohio Railroad, on location surveys in Virginia and West Virginia, continuing in this line of work until the fall of 1890.

At this time an offer of a fellowship in civil engineering was received from his Alma Mater, Cornell University, which was declined with some hesitency in favor of on offer of a position as instructor in civil engineering at Washington University, St. Louis.

The decision turned out to be a fortunate one, however, for at Washington he was brought into close association with the late Dean Johnson, who was then Professor of Civil Engineering at that institution.

It was while Professor Turneaure was at Washington University that the greater portion of "Modern Framed Structures" was written. This work was the joint production of Messrs. Johnson, Turneaure and C. W. Bryan, the latter then being engineer for the Edge Moor Bridge Company. This treatise on the design of framed structures is now in the eighth edition and is a recognized standard all over the world, a translation having recently been made in the Japanese language.

In the fall of 1892 Professor Turneaure came to the University of Wisconsin to take the newly created chair of Bridge and Sanitary Engineering which he has held until his recent election as Dean.

He was on leave of absence during the year of '95–'96 when he made an extensive tour of England, Germany and France with the special object of studying the foreign methods of sanitation and bridge design.

In 1901, in conjunction with Dr. H. L. Russell, Professor of Bacteriology in the College of Agriculture of the University, he published a work on "Public Water Supply," which is a work of great value as the subject is dealt with from the standpoint of both the hydraulic engineer and the bacteriologist.

In 1897 Professor Turneaure conducted an extensive series of experiments on the stresses in bridge members due to moving train loads, the results of which were first published in the Transactions of the American Society of Civil Engineers and attracted wide attention. The results obtained contributed largely to more exact methods of design, and have been made use of in the preparation of specifications.

Professor Turneaure was Clty Engineer of the City of Madison during the two years 1900 and 1901 and while serving in this capacity he designed two engineering works of vital importance to the city, the first of these being the pressent septic sewage disposal plant which successfully solved this troublesome question. The second was the installation of a system of auxiliary pumps in the artesian wells from which the city's water supply is drawn, this demonstrating a method by which an abundant supply of wholesome water may be obtained for many decades to come.

Dean Turneaure is a member of the following engineering and scientific societies:

Associate member of the American Society of Civil Engineers; Western Society of Engineers; Society for the Testing of Materials; American Railway and Maintainance of Way Association; American Association for the Advancement of Science. He is president of the Science Club of the University during the current year.

Dean Turneaure has always taken an active interest in the city's welfare, believing this to be his duty toward the students, as well as a duty to be expected from every citizen. After retiring from the office of city engineer which he held as a non-partisan, he was elected a member of the Common Council as a representative of the fifth ward, an office he holds at the present time.

Mr. and Mrs. Giles Turneaure, parents of the Dean, now make their home in Madison, having moved here in 1901.

Dean Turneaure was married in 1891, to Miss Mary D. Stewart, of Anchor, Illinois, and they have one child, a son, Stewart, now four years of age. Mrs. Turneaure is also a graduate of Cornell of the class of 1890, and unites in her character a strong personality with a winning manner. She is an able assistant to her husband in all his work.

When Dean Turneaure began his duties as Professor of Bridge and Sanitary Engineering in 1892, the faculty of the college consisted of nine members including the instructors and there were but 197 students in the whole college, little more than half as many as there are in the present freshman class. The change from a small department of the Unviversity to a separate college was just beginning, and aside from the then small shops, all there was of it including laboratories was quartered in a portion of the north end of Science Hall.

The year and a half during which Dean Turneaure served as Acting Dean was a time of great prosperity and substantial growth for the College, and showed his marked capability for executive work. His close identification with thc College during its years of rapid development has made him thoroughly familiar with its workings, and needs for the future, and his selection as Dean a particularly fortunate one for the needs of the College.

NEW YORK RAPID TRANSIT.

BY F. O. DUFOUR.*

On March 24, 1900, in front of the city hall, and in the presence of the Commissioners of the Rapid Transit Board and the various city officials, the mayor of the city turned the first spadeful of earth, as a formal beginning of the construction of the underground railway which is to constitute

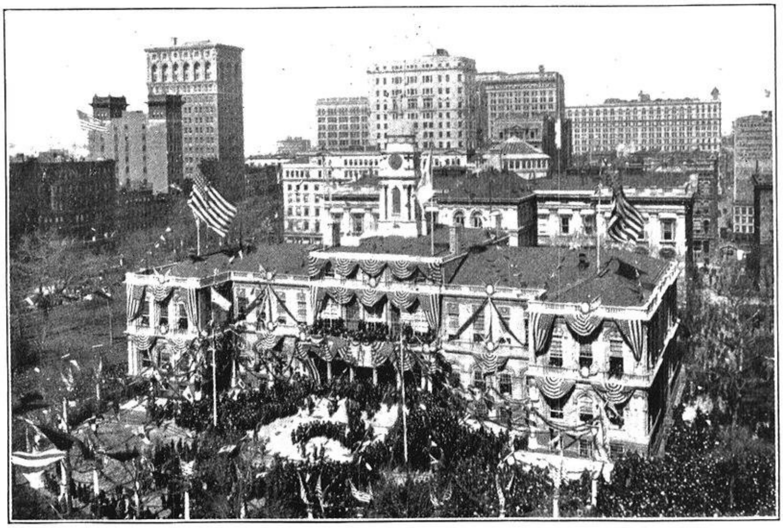


Fig. 1—Ceremony of Beginning Construction of New York Rapid Transit Subway.

the successful termination of almost incessant effort, since the year 1868, in the interest of adequate rapid transit. (Fig. 1.)

It will be seen by the above date that the idea of rapid transit is not new, and so in order to follow its growth, mention of the early attempts will be made.

Beginning with 1850, and for ten years thereafter, the movement of passenger traffic was successfully accomplished

* In charge of Steel Works of Worth St. Station and vicinity.

by means of the surface railways. The rapid growth of the population and the increase of business made it apparent that adequate means should be adopted in the near future for betterment of passenger transportation.

In 1868 the Legislature granted a liberal charter to the New York Central Underground Company. This company found it impossible to raise the funds required, and soon passed out of existence. In 1872 the Legislature incorporated the New York City Rapid Transit Company to construct and operate an underground railway. Commodore Vanderbilt was the head of this enterprise, and with usual energy pushed the work. The surveys and plans for construction were made when adverse criticism, which had started with the granting of the charter, became so great that Mr. Vanderbilt decided to abandon the enterprise.

Other charters were granted by the legislature, but all of the companies came to naught on account of being unable to finance their enterprises.

In 1875 the first Rapid Transit Act was passed by the Legislature. The elevated railways were constructed under its provisions, and for a time the congestion of traffic was relieved. In 1844 conditions again became such that relief must be sought by building of additional lines underground or otherwise. Several schemes were advocated, and finally an act was drawn up to be submitted to the legislature in 1888.

So great was the opposition, of adverse interests, that even after the mayor appeared before the Committee of the Common Council and pleaded for its passage, it was not even reported, and so died a premature death.

In 1891 the traffic was in such a congested state that sharp business practices and political moves could no longer keep the public's opinion from making its influence felt in the Legislature, and the so-called Rapid Transit Act of 1891 was passed.

This Act provided for the continuance in office of the members of the Act of 1875, and required that they should ascertain whether or not the construction of a rapid transit railroad was necessary. In case a necessity for such a road was found to exist, they were first to decide upon the routes and general plan of construction; second, to obtain the consent of the property holders affected, or of the General Term of the Supreme Court; third, to adopt detailed plans for the construction and operation; and fourth, to sell the right to construct and operate such railroad to be formed, under the terms of said act. This Act also gave the Commissioners the power to grant additional franchises to existing railroad corporations. This last power was in time to become a most effective weapon for the use of adverse business interests in hampering and delaying the work of the Commission.

The Board at once appointed Wm. E. Worthen and Wm. Barclay Parsons as engineers, to cooperate with them, and shortly afterwards decided that a rapid transit railroad was necessary and that the underground road was the only means by which the necessary additional facilities could be acquired. The surveys and plans were then made, submitted to and approved by a board of experts and transmitted to the Common Council on October 20, 1891. The necessary consents and approvals being obtained, contract drawings were prepared, together with the specifications, and on December 29, 1892, the franchise was offered for sale to the highest bidder. No responsible bidders being found, the labors of the Commission proved barren of visible results.

Directly after the failure to sell the franchise, the Manhattan Railway Company applied for franchises to build on a number of additional streets and thus relieve the congestion. While these negotiations were in progress no other schemes were agitated, but the company being unwilling to make any compensation to the city, as was thought to be sufficient by the Commission, the matter was dropped in the month of August, 1893, and the rapid transit question was again agitated.

On May 22, 1894, Governor Flower signed the Act of 1894, thus making it a law. Under this act a new Rapid Transit

Board was created. The mayor, the comptroller and the President of the Chamber of Commerce, were *ex-officio* members, and Messrs. Wm. Steinway, Seth Low, John Claflin, Alexander E. Orr and John H. Starin composed the active members of the board. To the untiring efforts of the above members, with few changes made necessary by politics and the march of time, together with their counsel, and Mr. Wm. Barclay Parsons, whom they appointed their chief engineer, are due the credit for the final success in bringing about the construction of the New York Rapid Transit Subway.

The Act left unmodified the conditions of the Act of 1891, and in addition required that they should either adopt the old plans or provide new ones, and also that the Board should submit to the people, at the next general election, the question whether the railway should be conducted by the city and at public expense. If the question was decided in the negative the Act provided that the Board should sell the franchise as provided in the Act of 1891.

The method by which the road was to be constructed by the city at popular expense, and the conditions imposed thereby were as follows: The contratcor was to operate the railroad, as the lessee of the City for a term of not less than thirty-five or more than fifty years at an annual rent sufficient to pay the interest on the money for bonds, which were to be issued to raise money for the construction, and one per cent. in addition thereto. He was to supply his own equipment which was to be free from taxation, was to furnish bond as determined by Board, was to deposit $1,000,000 with the City Comptroller, which was to be returned when the road was completed, and was to give the City a lien on his equipment. It further provided that the total cost should not exceed $50,000,000. By amendment in 1895 it provided that litigation caused by abuting property interests would be assumed by the city.

At the election held November 6, 1894, 184,035 votes were cast; 132,647 affirmative, 42,916 negative; 399 defective and were not counted, thus showing a large majority in favor of municipal construction.

The Commission with the assistance of its Chief Engineer performed the necessary preliminary work, and after due consideration decided to adopt Broadway as the location of the down town portion of the system, believing that the increased traffic would more than compensate for the necessary additional cost. They estimated that the cost might be in excess of the fifty millions as prescribed by the act. A board of experts being appointed to examine the plans did so, and recommended that Elm street be used as the location of the down town portion. This, together with other minor changes, reduced the estimated cost to about $42,000,000. They also estimated that the construction of the road, after the plans proposed by the Commission, would cost $50,000,000.

The Commission failed to see the necessity of the changes as suggested by the board of experts. It obtained the consent of the City authorities, but upon applying to the Court, in formal matters relating to property rights, it was enjoined from further proceedings. After about a year of litigation the Supreme Court refused to allow the road to be constructed. The reasons for this decision were that the service would not be adequate, and that the expenditure of such a vast sum of money would prevent the Ctiy from engaging in any other public work, and that the City's credit would be greatly impaired. Although not definitely stated, it was evident that the court would not favor any route under Broadway.

Adverse interests instigated litigation at this time, questioning the constitutionality of the Rapid Transit Act. The Act was decided as constitutional, February 20, 1896.

After five years of incessant effort the labors in behalf of rapid transit facilities seemed destined to a fatal ending. Counsel for the Board aided by letters from influential persons, together with the cry of popular indignation decided the Board to make another attempt. Accordingly the Board, taking the view that the court would probably approve of a plan which did not use Broadway, which would cost $50,000,000 or less, and which could be shown by balance of testimony to be adequate to relieve the congestion of traffic, proceeded with this end in view.

At this period of the proceedings the Manhattan Railway Company, availing themselves of the Board's authority to grant additional franchises, applied for franchises to build upon additional streets. This application was of a very general nature and also included a request for privileges which were not within the power of the Commission to grant. Upon a suggestion by the Board, as the correct requests to make no reply, was made by the Company until nearly two years afterwards when the actual construction of the Rapid Transit Railroad became probable.

The Board after due consideration adopted the "Elm Street Rout" (see Plate I) on Jan. 14, 1897. The road was to begin at the intersection of Park Row and Broadway on the south, and thence with four-track roadway to about One-Hundred and Third street and the Boulevard. At this point it branched, one branch terminating near Kingsbridge station of the New York and Putnam R. R. Co., the other terminating at Bronx Park. Both branches were of double track roadbed. Under Park Row and around City Hall a loop was provided. This is known as the City Hall Loop. The general plan of construction and operation was included in the Act. It was further estimated to cost $35, 000, 000. The interests south of the City Hall, along Broadway, memoralized the Board, asking that the road be extended southward under Broadway with a loop under Battery Park. This project came to nought owing to the refusal of the Park commissioners to allow its construction in the Battery Park. The consent of the local authorities for the construction and operation of such a road having been obtained, the Appellate Division on November 6, 1897 appointed a commission to ascertain if the road should be constructed and operated.

This commission decided, as had all such previous commissions, that such a road was necessary and so reported to the Appellate Division of the Supreme Court.

The Court gave its decision, on December 17, 1897, in which it confirmed the report of the Commission. Among the stipulations contained in its opinion, was the requiring of

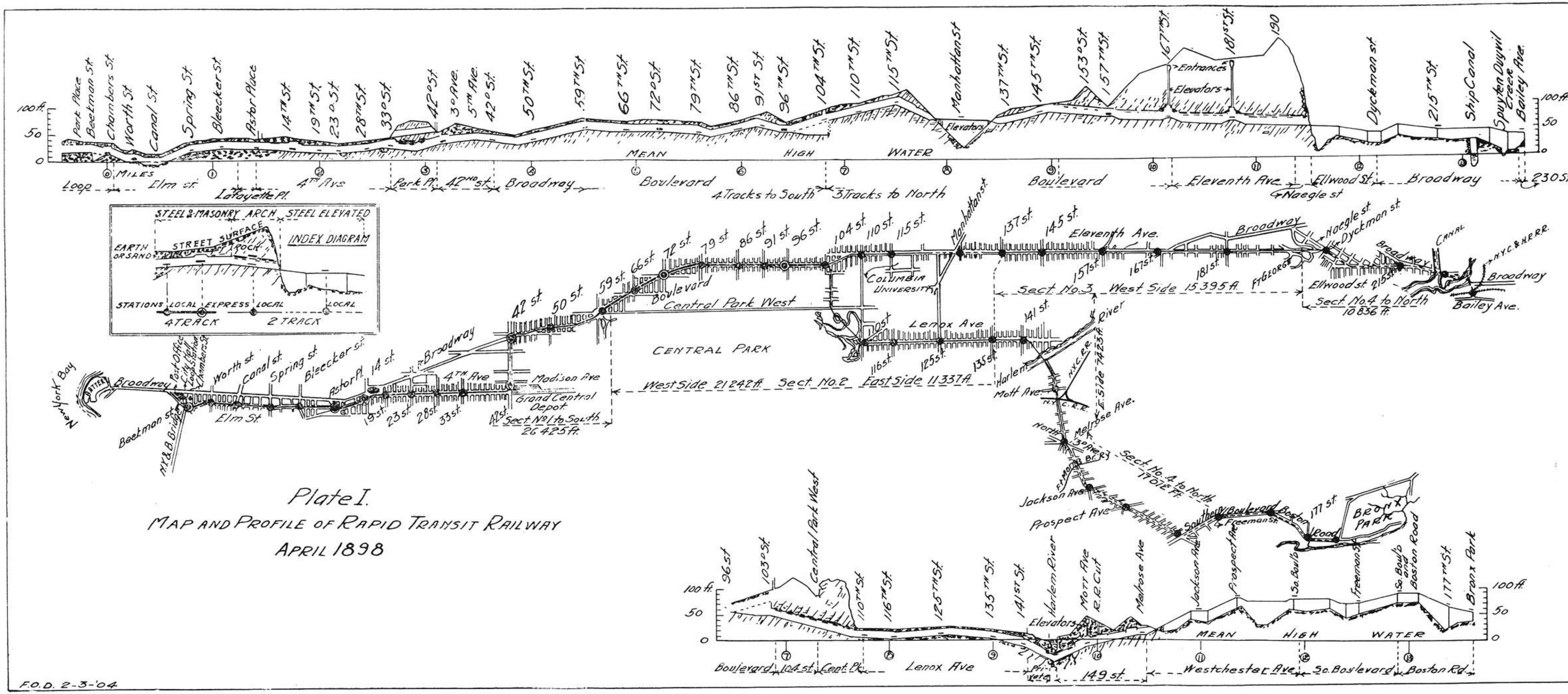


Plate I.

MAP AND PROFILE OF RAPID TRANSIT RAILWAY

APRIL 1898

F.O.D. 2-3-'04

a bond of $15,000,000 to be given so "as to protect the interests of the city in a substantial manner" until the road reverted to the city in the thirty-five or more years after completion.

The enormous amount of bond and the long time it was to run, enabled people with even a superficial knowledge of finance to see that should the Court insist upon this condition the project was once more side tracked indefinitely.

The Manhattan Railway Company now made public their intention to extend their lines as soon as the right could be procured.

The Charter for the City of Greater New York was also adopted at this time (January 1, 1898).

Both the above actions delayed the project. Responsible bidders would hesitate to build if the Manhattan Railway was to cut down or render questionable the profits. The influence of the annexed counties was in most cases against using the credit of the City in an undertaking from which they were to receive no immediate advantage.

The Board was, however, undeterred by these acts and appointed a sub-committee to investigate existing conditions, consult intending bidders and ascertain if possible if a $15,000,000 bond could be procured as required by the court. On January 13, 1898, this sub-committee made its report. It recommended that no bids be asked for until the elevated railway companies had decibed either to build on additional streets, or not, as prospective bidders hesitated to assume the obligations with uncertainty regarding the profits; that if the court insisted upon the technical form of the $15,000,000 bond it would substantially prohibit the successful termination of the enterprise; that the court be requested to limit its requirement to a bond for construction only and allow the Board to fix the bond for operation and payment of rent; and that the last mentioned bond be eqnal to seven years rental, the city's lien on equipment being included in this. Upon the court being appealed to it modified the requirements to the extent that a $15,000,000 bond was required during construction and a $1,000,000 bond be required during period of rental.

The matter regarding the extension of elevated lines was taken up and inasmuch as the companies interested failed to approve the franchise offered by the Board, this cause of delay was no longer active. The contract was now prepared, and on March 31, 1898, sent to the corporation counsel with

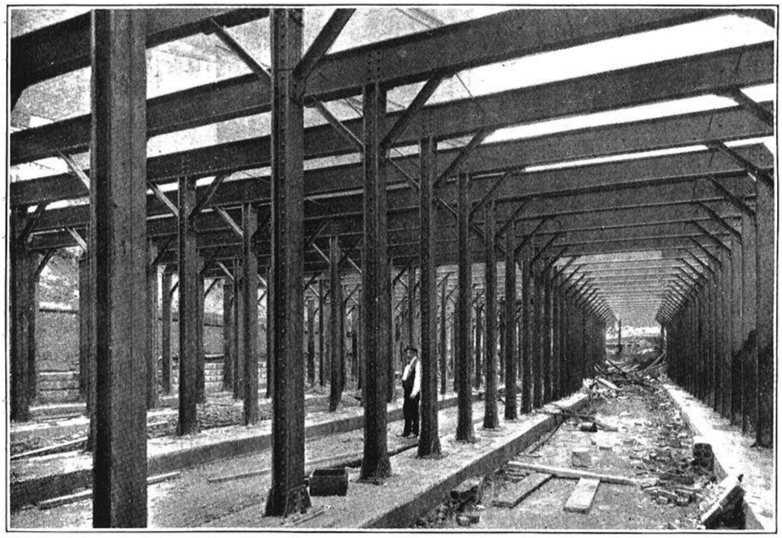


Fig. 2—General Arrangement of Steel Works.

the request that it receive attention at once. No reply was had until September 20, 1899, when the Board received a letter from the Counsel criticising the contract in various points.

During the time between the sending and returning of the contract the Board addressed a memorial to the Legislature upon the proposed methods of financing the enterprise. They also addressed the Mayor upon the subject, but no reply was received to either communication.

The hesitation to take undue haste may perhaps have been due to the fact that with the consolidation of the suburbs into the city of Greater New York, a large increase in the city debt was made, and this increase brought the total debt nearly to the amount of the 10 per cent. of assessed valuation of property allowed by the Constitution.

A revised draft of the contract was sent to the Corporation Counsel on October 6, 1899, and five days latter it was approved. The Corporation Counsel also joined the Board in another appeal to the Appellate Division of the Supreme Court to reduce the bond for construction, and on November 10, 1899, the Court decided that $5,000,000 was sufficient.

Bids were now asked for, and January 15, 1900, set as the date for opening. Two bids were received, one from John B. McDonald, and one from Andrew Onderdonk. Mr. McDonald's bid was for $35,000,000, and Mr. Onderdonk's bid was $39,300,000, in addition to which he proposed that, in case the gross receipts exceeded $5,000,000 in any one year, to pay in addition to the rent fixed by law, five per cent on the first million dollars in excess, and two and one-half per cent. for each additional million up to a maximum of fifteen per cent. A deposit of $150,000 accompanied each bid.

After due consideration the Board accepted Mr. McDonald's bid. After some minor litigation regarding the issuing of the bonds was favorably ended, the Board came to an agreement with Messrs. August Belmont & Company, who were to attend to Mr. McDonald's financial arrangements, as to the manner in which the financing was to be accomplished.

In brief the plan was that:

1st. Messrs. August Belmont & Company to organize a corporation under the laws of the state of New York, with a capital of $6,000,000. This company (afterwards the Rapid Transit Subway Construction Company) to enter into a contract with Mr. McDonald to promote the construction of the work, to furnish his security and to finance his undertaking.

2d. To reduce the minimum to be taken by each surety from $500,000 to $250,000.

3d. The Rapid Transit Subway Construction Company should become surety on Mr. McDonald's bond to the amount of $4,000,000.

4th. Mr. McDonald was to make the necessary deposits required by the law.

5th. Mr. McDonald agreed to assign to the city his benecial interests in the bonds of the sub-contractors.

A few of the most salient terms of the contract are:

That the road was to be constructed for the sum of $35,000,000.

Fig. 3—Finishing Concrete Side Arches.

That the contractor was to lease the road for a period of fifty years, with an additional twenty-five years at his option. The rent for the additional twenty-five years to be mutually agreed upon.

That at the expiration of the lease the equipment was to be turned over to the city at once; the price to be agreed upon later.

That work was to be begun in thirty days, and completed within four and one-half years.

That the cost of the terminals were to be extra, but must not exceed the sum of $1,750,000.

That monthly payments would be made the contractor upon certificate of engineer showing work done.

That the average speed of local trains, stops included to be not less than fourteen miles per hour, and the speed of express trains not less than thirty miles per hour, stops, included.

That the motive power should be electricity or compressed air.

That the fare shall be five cents, and that not more than one private car can be carried on any train.

Previous to the beginning of construction a committee from the representative citizens of Brooklyn appeared before the Board and advocated the extension of the Rapid Transit Railroad under the East River to the Borough of Brooklyn. A bill was introduced in the legislature amending the original act to extend the powers of the Board to all parts of the Greater City of New York. This was passed, and after the necessary consent of the local authorities was obtained, the court took up the matter.

The Board, during the fall of 1900, took up the question of connecting with the lines of the New York Central R. R. Company in order to use its tracks northward to run through suburban trains. This project came to naught as the New York Central was unwilling to have tunnels beneath their property.

Construction was begun as noted at the head of this article, and present indications are that it will be finished well within the contracted limit of time.

ENGINEERING FEATURES.

The engineering staff consists of a Chief Engineer (Mr. Parsons), a Deputy Chief Engineer, six Division Engineers, five general inspectors, a private secretary, an auditor and a photographer. These men were appointed. The positions of assistant engineers, draftsmen, axemen, etc., were filled by competitive civil service examinations.

It is of interest to note that both the Chief Engineer and the Deputy Chief Engineer are college graduates.

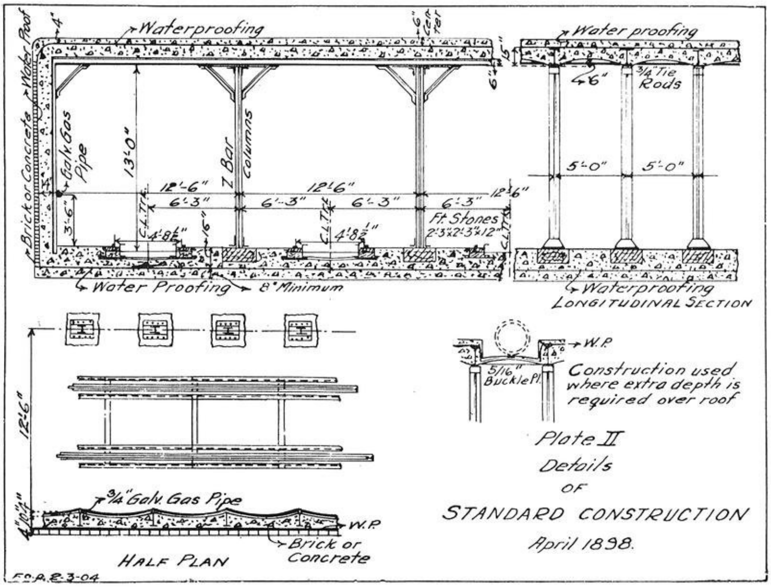
The following are the percentages of college graduates in the different positions: Division engineer, 71.4; assistant engineers, 85.3; rodmen, 75.3; axemen, 36.6. This gives a grand total of 74.6 per cent. of college bred men on the engineering staff. Columbia has 27; Harvard, 10; Cornell, 9; Cooper Institute, 5; Rensselaer Polytechnic, 5; Mass. Tech., 4; Union College 4, and Lehigh University, 4 engineers. Of the remaining thirty-six colleges, five have two, twenty-one have one and the remainder have no engineers. The only western university represented is the University of Michigan who has an assistant engineer. The London Polytechnic has one rodman to its credit as the only foreign representative.

The method of construction has been that of open excavation for the most part. The location is in the center of the street. The standard construction consists of intermediate Z-bar columns supporting a roof of I-beams and buckled plates. The side colums are of I-beams. Columns were placed between the tracks in order to reduce the depth of the roof beams so that the distance from the street to station platform should be a minimum. The buckled plates are covered with concrete to the level of the upper flanges of the beams, and then a layer of water-proofing, consisting of alternate layers of tar and felt is placed, and additional concrete put on top of this. When finished the top is in many cases thirty inches, the depth of yokes of electric surface roads, from the street surface. Vertical concrete arches are used on the sides with an intermediate layer of water-proofing. A flat layer of concrete is placed on the bottom and after the water-proofing is put in place, another layer of concrete is laid on. The footing stones for the columns and the roadbed for the track are now put in place and the final layer put on. Plate II. shows this general construction. Figs. 2 and 3 show the steel work in place and the side arches in process of construction.

The track is of standard gage. The rails rest upon continous longitudinal wooden stringers which are made of oak blocks laid cross-wise and in between two channels which are connected at intervals of about five feet by I-beams which extend cross-wise the track similar to the familiar wooden ties.

The stations which are placed at the intersections of streets are finished for the most part in different colored enamel brick of a very good quality.

It was intended to place the various water, sewer and gas mains in tunnels upon either side of the subway, but this ob-



ject has been abandoned. They are carried across the top if clearance will admit, but in many cases this will not permit and the mains are divided and placed on either side of the subway. In many cases it has been necessary to construct entirely new mains on either side of the subway. In other cases large sewers were divided into two or even three smaller ones in order to pass under the tracks.

The contour of the rout at times demanded tunnels. These were used as seldom as possible, both on account of great cost of construction and on account of inaccessibility of stations which had to be reached either by long flights of stairways or by elevators.

That portion of the railroad which is in especially comparatively thinly populated and now business districts is constructed of elevated viaduct. This has the advantage of ease of construction and cheapness.

Altogether it will be seen that the methods of construction as far as the actual work on the railroad is concerned is of a not very difficult nature. The great difficulties were experienced in keeping in commission the great mains and large buildings when blastings were required either under or at least very near. The noninterruption of surface railway traffic was another important problem which had to be solved. The general method was to span the excavation by I-beams or heavy timbers and to lay the tracks upon these and suspend the mains from them by means of chains and ropes.

Up to December 31, 1901, 65,400,000 pounds of steel, 9,050,000 pounds of cast iron, 188,400 barrels of Portland and 15,900 barrels of natural cement were used on the work. About $12,600,000 was spent, 4 per cent. of which was for "engineering." Out of 211 casualties, during this period, 16 were fatal and only one of these happened to an outsider.

To quote the Hon. Abram S. Hewitt, to whom the success of the rapid transit movement is largely due, "one thing is certain that the Rapid Transit System adopted by the Commission will be fully completed and put in operation without involving any additional taxation whatever, and at the end of fifty years it will be the absolutely unincumbered property of the city. Compared with other enterprises in other cities it must be conceded that the arrangement made for the construction of this work is the most favorable that has ever been devised or accomplished" and "if we can secure municipal government which will enable great public works to be undertaken and carried to completion with the same economy and honesty that have characterized the execution of the Erie Canal, the Croton Water Works, and the Rapid Transit System, no reasonable limits can be assigned to the future growth of this city in prosperity and grandure.

The subject matter for this short sketch is in the main taken from the Report of the Rapid Transit Board for 1900-1901 and by their courtesy the accompanying photographs and plates are reproduced.

SOME USES OF ELECTRICITY IN THE WORKING OF METALS.

C. F. BURGESS.

Present methods of working metals involve the use of electrical energy in so great a variety of ways that even a reference to all of them is scarcely possible within the scope of a short paper. It is proposed, however, to point out various electrical properties and phenomena which have been utilized and which in themselves would seem to indicate that as a more general and thorough knowledge of electricity is acquired, its sphere of usefulness will widen and its application to the metal working industries will increase.

Perhaps the first application of electricity to the treatment of metal objects was made over half a century ago when electroplating came into vogue. So steadily and unostentatiously has this industry grown that it has not attracted the popular attention which its importance deserves. Nearly every metal working plant of considerable size now has its plating department, and estimated on the basis of product turned out and on the value or ornamentation and protection against corrosion which electro-deposited coatings afford, it may well be ranked as one of the most important industries of the present time.

The application of the electric current to this purpose created the first and most pressing demand for cheap methods of generating electricity, and the earliest electric generators were made and used for electroplating. As a result of rapid development of electric machinery which followed came the electric drive, and methods of speed, control and regulation to which is largely due the many improvements in design and efficiency of operation in the modern machine shop.

The magnetic effect of the electric current has recently been successfully applied in the quick-acting magnetic clutch, and the electro-magnet used for lifting and handling sheet iron is a labor-saving device of no little importance.

The heating effect of the current when passing through a metal resistance has been utilized in an important machine known as the electric welder, which enables certain classes of work to be welded not only more quickly and cheaply than could otherwise be done, but which also makes better welds, and does certain kinds of work that were impossible under the older methods.

Another means of heating by electricity to a welding heat is through the use of the electric arc playing between carbon terminals or between a carbon terminal and the metal itself. This method has certain advantages over the one previously referred to, in that the heat can be more directly localized at a certain spot and upon certain metal forms which cannot be placed in the jaws of the electric welder. It is used for filling blow-holes and remedying defects in castings, and its advantages have been recognized in both the legitimate and illegitimate opening of metal safes. The place held by the arc welder is, however, of far less importance at the present time than that occupied by the other type, known commonly as the Thomson welder.

Other uses for electric heating are the annealing of wire, the maintaining and regulation of the temperature in tempering baths and annealing furnaces, and for case-hardening.

The electrolytic effect of the current has been referred to in the deposition of metals for ornamental and protective purposes, and there are numerous other applications of electrolytic phenomena which are now being used, and which will be introduced in the future. The term "electrolytic copper" under which the largest percentage of the world's output of copper now goes, implies one of the most important uses of the current, as by this means metals may be recovered from their ores and refined after being separated by electrolytic or other methods.

The important part which electrolysis plays in the production of copper, nickel, gold, silver and certain other metals, is well known, but should be classed under the production rather than the working of metals. Among the various minor uses of the electrolytic cell are the cleaning and removal of undesired materials from a metal surface, the removal of one metal from another, oxidizing and coloring, etching and drilling.

In the preparation of a metal object for receiving a coating of lacquer, enamel, or electroplating, an absolutely clean surface is desirable, and for this purpose one or more of the various electrolytic phenomena may supplement or replace with advantage the older chemical or manual methods. The electric current exerts an oxidizing action at the anode, and a reducing action at the cathode, with a consequent production of various chemical compounds. The production of an alkali hydroxide in this manner may cause a saponification of oil and grease, and the reducing action may at the same time reduce and remove rust and various oxides. By placing the object to be treated, as the anode in a salt solution, the action which takes place is similar to that which would occur with the corresponding acid, and the ordinary pickling solution may thereby be replaced. In addition to the chemical action, the liberation of hydrogen or other gaseous products which may be produced, exerts a physical action in removing from the metal surface any loosely adhering materials. In this manner a layer of enamel, lacquer, or paint may be removed from a metal article by suspending it for a few minutes, as the cathode in a sodium hydroxide solution.

When, as is frequently the case, it becomes desirable to remove a coating of metal, it may be done most satisfactory by the so-called electrolytic stripping process, in which the article is used as the anode in a suitable solution, the current causing a dissolution of the coating. Where work is to be replated, the removal of the previous coating is necessary, and is best done in the manner suggested. Some years ago a process was developed in our Applied Electrochemistry laboratory for the removal of thin layers of brass from iron, and this method is now in extensive use in bicycle and other factories. In the brazing process where the article to be brazed is dipped in a bath of melted brass, the entire surface immersed becomes coated with a thin layer of the metal, which subsequently must be removed. The difficulty in dissolving this coating lay in the fact that in most solutions the iron is more readily corroded than is the brass, but it was found that by using a sodium nitrate solution in which the iron assumes the so-called "passive" condition, the brass can be removed entirely without injuring the iron. In the treatment of a bicycle frame in his manner, a saving over the older method of filing by hand was effected, reducing the cost from about twenty-five to less than five cents per frame.

Files which have been used upon soft metal, such as copper, brass, or lead, and have thereby become clogged, may be completely freed in a few minutes by making them serve as the anode in a sodium nitrate solution.

A somewhat similar method for sharpening worn files has been suggested, though apparently it has not been put to extreme practical use. The solution in this case is one which causes a corrosion or dissolving of the steel, and is similar to the well known acid treatment of files.

The corrosive action of the current at the anode has also been utilized in etching metals, two methods being available. One of them is to coat the surface with wax or other non-conducting medium through which the desired inscription or design is drawn. A subsequent corrosion produces a permanent impression. The other method is designed to avoid the necessity of previously treating the surface, the design being worked into the metal by projecting a fine stream of electrolyte against the surface, the current flowing from the metal through the stream. By moving the point at which the stream impinges, the locality or corrosion may be controlled. It is but a step from this method to the one which is employed for drilling or slotting metals. By maintaining the stream of electrolyte in one fixed position the corrosion may be made to proceed deeply into the metal. This offers the advantage over the ordinary manner of drilling in that irregular shaped holes may be made. Its very slow rate, however, precludes its general use, except in certain special cases, one of which is the piercing of specially hardened armor plate which is so hard that it cannot be machined by any of the ordinary tools.

To the uninitiated, the operation of the electrolytic forge has a somewhat startling effect. About ten years ago the dipping of an iron rod into a solution of common washing soda with the simultaneous heating to a welding and even a melting temperature was heralded as a successor to the older method of using a forge fire. The cause of the heating is the current which liberates a layer of hydrogen around the iron, and it is the current which passes through this high resistance envelope that is supposed to cause the heat development. The advantages which were claimed for it were rapidity, cleanliness and the impossibility of forming a scale or introducing impurities on account of the reducing action of the hydrogen, but in spite of these claims the liquid forge has not become of practical importance on account of one serious objection, which is the expense for power. The press- necessary to maintain a sufficiently high current density to produce the heating is over 250 volts, and as there are very few direct current circuits installed operating at that pressure a special dynamo would be necessary. To obtain the current from a 500 volt railway or motor circuit involves the use of a wasteful resistance, and even without such waste the power actually consumed is considerable. An iron rod one-half inch in diameter requires fifty amperes, which at a pressure of 250 volts means power consumption at the rate of 17-horse power.

Some experiments which were performed in our laboratory show that it is possible to obtain the same heating effect with an expenditure of from five to ten per cent. of this power, by replacing the liquid with powdered graphite having a good conductivity. Measurements were made by using a round iron vessel containing the finely divided graphite, the vessel constituting one of the electrodes to which connection was made to one of the terminals of the secondary of a transformer. The other terminal was connected to the rod to be heated, and the end of this was immersed in the graphite. The current thus flowing from the sides of the vessel to the rod, placed concentrically within it, reached a high current density in the immediate neighborhood of the rod and thus produced heating. In addition to this heating, innumerable small arcs were produced at various points of contact be-tweed the iron and graphite, thereby increasing the heat. Either altern ating or direct current serves equally well for this purpose, and the pressure required being about 25 volts, and the current necessary somewhat less than that of liquid forge. As far as consumption of power is concerned this method of heating would be entirely practicable. A difficulty in its operation, however, lies from the fact that where the heat is the most intense a cloud of the fine graphite arises, making the process a dirty one as well as one wasteful of graphite. It is possible that by incorporating the graphite with suitable inert material this objection could be overcome, but the experiments were not carried far enough to determine this point.

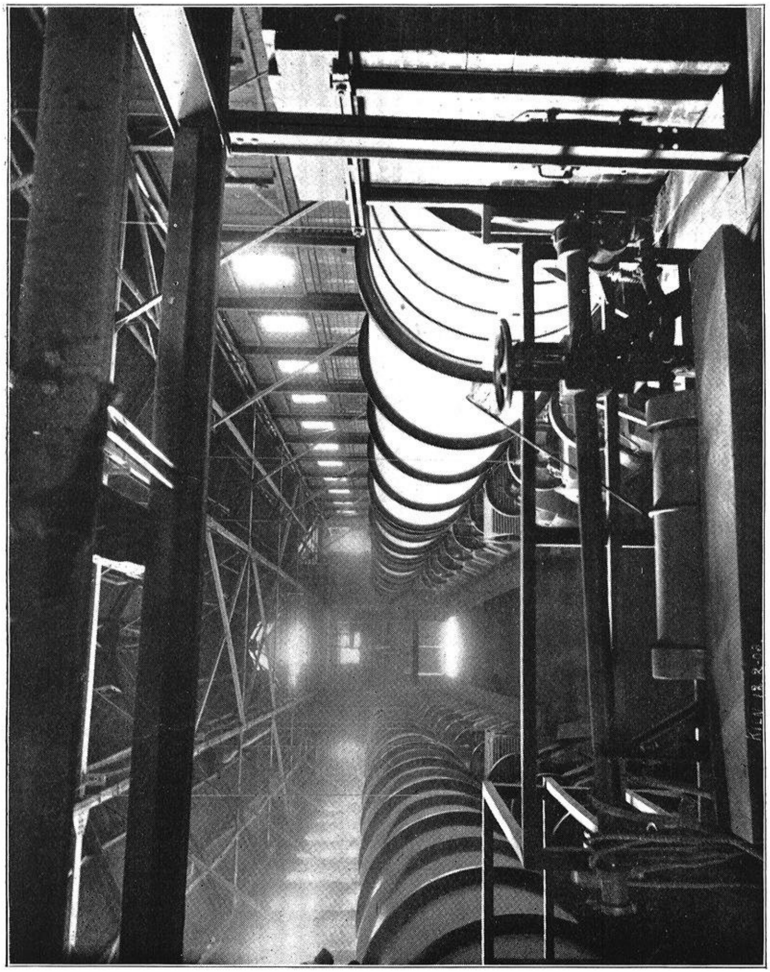
ENGINEERING PROBLEMS IN PORTLAND CEMENT MANUFACTURE.

BY S. B. NEWBERRY.

The development of the Portland cement industry in this country is one of the most remarkable achievements of American engineers. Portland cement was first made in England about 1824 by calcining, at high temperature, a mixture of chalk and clay. The industry rapidly developed in England and was soon established in France and Germany. The first attempt to manufacture Portland cement in this country was made by D. W. Saylor, at Coplay, Pa., about 1870, but was not fully successful until about 1875. Up to 1890 practically all the Portland cement used in the United States was of foreign manufacture. In that year the American product amounted to 335,000 barrels, while over two million barrels were imported. Since that time the production in this country has increased at an average rate of over 40 per cent. per year, and in 1903 nearly twenty million barrels were manufactured in the United States. This branch of manufacture may now be counted as one of the greatest industries, and there is every reason to believe that the future will show a still greater increase.

Before speaking of the engineering features of the Portland cement industry, a few words of explanation in regard to the different classes of hydraulic cements may be of interest.

It is well known that lime, which is generally used for mortar, has no hydraulic qualities, and will not harden unless exposed to the air and allowed to become dry. It is, therefore, unsuitable for work which is to remain moist or to be kept under water. The ancient Romans discovered that *pozzolana*, a volcanic scoria found in the neighborhood of Naples and Rome, had the property, when mixed with



Rotary Kilns, 150 feet long, Edison Cement Co., Stewartsville, N. J.

slaked lime, of producing a hydraulic mortar which would harden in water. Mixtures of pozzolana and lime with broken stone or brick were used by the Romans on an enormous scale, as *concrete*, in all their constructions, and the work done with this material has shown extraordinary durability. The Roman Pantheon and many other great structures were built almost entirely of concrete, with immense vaulted roof, cast in a single piece, which would not be possible of construction with stone or brick.

Until the middle of the eighteenth century pozzolana cement was practically the only hydraulic building material known. In 1756, Smeaton, the engineer of the Eddystone lighthouse, investigated different kinds of lime, and found that the limes which contained a considerable amount of clay possessed distinct hydraulic properties and gave much better results, when mixed with pozzolana, than purer limes. His observation passed almost unnoticed. It was not until 1818, when Vicat, an eminent French engineer, fully investigated the subject, that the effect of clay in giving lime hydraulic properties was recognized and understood.

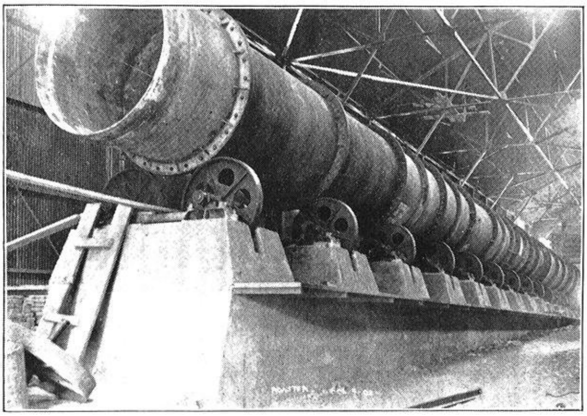
In 1796, a hydraulic cement was made in England by calcining, at low heat nodules of limestone containing a large amount of clay, and was termed Roman cement. In modern times, cement made from natural limestone containing clay, and called natural cement, is widely manufactured and used. After Vicat's researches, the manufacture of *hydraulic lime*, by calcining limestone containing a small amount of clay and slaking the product, became an important industry in France.

The manufacture of Portland cement, patented by Aspdin, in England in 1824, was based on burning an artificial mixture of carbonate of lime and clay in exactly the proportions to give the best result. It was found that the use of correct proportions gave a mixture which would stand a very high heat without fusing, and that grinding the resulting clinker produced a heavy gray powder which would set and harden much more satisfactorily than the natural cement made from limestone containing an excess of clay, or hydraulic lime made from limestone containing an excess of lime.

Hydraulic cements may then be divided into four classes, as follows:

1. Pozzolana cement, a mechanical mixture of certain kinds of vocanic scoria or slag, and lime.

2. Hydraulic lime, made by calcining limestone containing a moderate amount of clay, and slaking and screening the product.



150 feet Rotary Kiln in Place.

3. Natural cement, made by calcining, at a moderate heat, limestone containing a considerable proportion of clay and usually much magnesia, and grinding the product to powder.

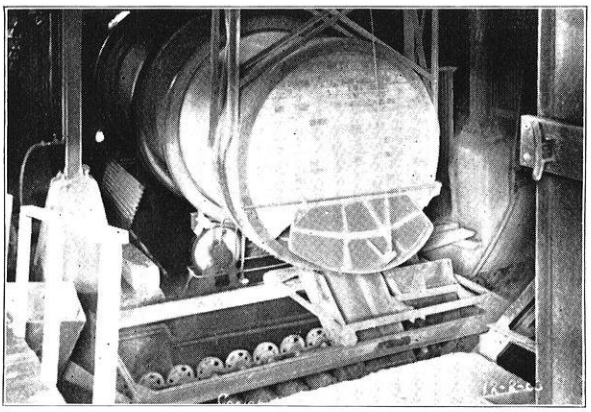
4. Portland cement, made by calcining at high heat an artificial mixture of carbonate of lime (limestone, chalk or or marl) and clay or slag, and grinding the resulting clinker to powder.

It is evident from the above description that Portland cement can be made anywhere in the world, providing limestone, chalk or marl, and clay are available. If a deposit of limestone of uniform composition and containing exactly the right amount of clay could be found, Portland cement could be made from it by simply burning and grinding. No such deposit is known or likely to be discovered; Portland cement is, therefore, always made from an artificial mixture of materials.

In Eastern Pennsylvania and western New Jersey occurs an unlimited deposit of limestone containing approximately the amount of clay required for a Portland cement mixture. This neighborhood has become the most important seat of the industry in this country, and nearly 70 per cent. of the American product is manufactured there. The cement rock is quarried and finely ground, with the addition of a small amount of pure limestone to bring it to the right composition. The mixture is then calcined at nearly white heat, and the resulting clinker ground. In the central and western parts of the country, marl, a finely divided, white deposit from fresh water, or pure limestone and clay are the materials used.

The "burning" or calcining of Portland cement was formerly done in vertical intermittent kilns, like lime kilns. These were filled with the mixture, previously molded into bricks and dried, and coke in alternate layers, ignited and allowed to burn out. About five days were required for filling, burning and removing the charge, and not more than eighty barrels of cement were obtained at each operation. Continuous vertical kilns, in which the material and fuel were charged at the top and the burnt clinker periodically withdrawn from the bottom, were to some extent introduced in Europe. These, also, required that the mixture should be molded into bricks and dried before burning. This operation, and the charging and emptying of the kiln, required a large amount of hand labor, and the use of the vertical kiln in this country proved, therefore, very expensive.

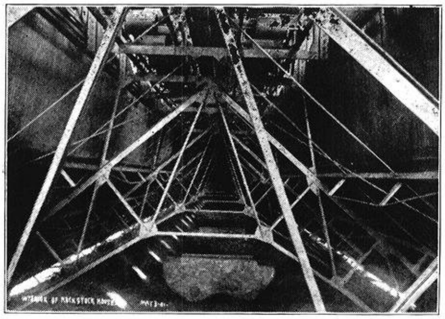
In 1885, Ransome patented, in England, a process of burning Portland cement mixture in the form of dust in a revolving cylinder heated internally by a flame of gas. This process was unsuccessful in England, but about 1890 was taken up in the United States, using crude petroleum as fuel, by M. de Navarro, at Coplay, Pa., and after many discouraging and costly experiments, was brought to a success. This process did away entirely with the costly labor of molding and drying the raw material in the form of bricks, and was thus especially adapted to the conditions prevailing in America, where fuel is abundant and labor dear. The introduction of the rotary kiln gave an immense impetus to the Portland cement industry in this country, and more than 600 of them are at present in use. The kilns now enployed are usually from 60 feet to 70 feet in length and about six feet in diameter .They revolve at the rate of one revolution in from one to three minutes. The raw material is introduced in finely powdered form, or as wet mud, at the upper end, and gradually descends through the nearly horizontal cylinder, parting with the carbon dioxide, becoming red hot and finally white hot,



Front End of Revolving Clinker Cooler.

and issuing from the cylinder in small rounded pieces of clinker. The passage of the material through the kiln takes about one hour. Owing to the high cost of oil this has lately been replaced entirely by powered coal. The coal is blown into the kiln at the lower end, through a pipe, by means of a blast of air, and burns with exactly the appearance of gas, producing a clear transparent flame and heating the interior of the kiln to a temperature of nearly 3000°.

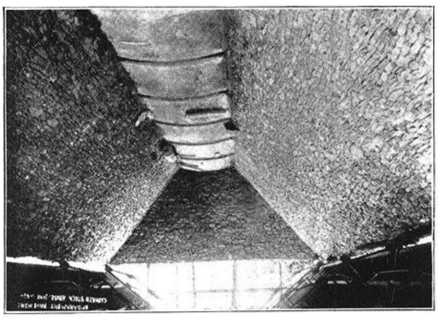
The only drawback to the rotary kiln is its high consumption of fuel. The old-fashioned intermittent kilns required about 80 pounds of coke to burn one barrel of cement. In the continuous vertical kilns the same effect was accomplished with about 50 pounds of soft coal. Rotary kilns, however, require, with dry material, about 110 to 120 pounds of coal per barrel, and with wet material 150 to 200 pounds. The clinker issues from the kilns at a bright orange heat, and the waste gases go up the stack (with dry material) at a temperature of 1,500 to 1,800°. There is evidently a great field for invention in the utilization of this waste heat. The heat passing up the stacks is capable, if utilized under boilers, of yielding 125 horse power for each kiln, or nearly enough to do all the grinding of the raw material and product. Attempts have been made to utilize this heat in vertical boilers, but up to this time interference with the operations of the kiln and accumulation of dust in the flues have rendered this addition of doubtful economy. There can be no doubt that engineers will ultimately succeed in solving this problem, and that modifications of the rotary kiln will reduce the fuel consumption approximately to that of thecontinuous vertical kiln.



Interior of Rock Stock House.

The grinding of Portland cement clinker to the fineness of the best Portland cement is a difficult operation. The clinker as it comes from the kiln is usually of pea or chestnut size, though lumps as large as eggs are of frequent occurrence with certain materials. Two systems of grinding are in general use in this country. The first is by the use of the Griffin mill, which is practically a mortar and pestle on a gigantic scale, consisting of a steel die 30 inches in diameter against which a 300-pound roll-head, suspended on a vertical shaft, presses by centrifugal force as it revolves. Plows at the bottom of the roll-head throw the clinker up against the ring, and the resulting dust is driven out through a circular screen, surmounting the die, by fans attached to the shaftt The Griffin mill does the whole work of grinding the clinker. to dust in one operation, and produces a large output. The repairs are, however, a very considerable item.

At a large number of factories the grinding is done by ball mills and tube mills. The ball mill consists of a drum made of steel plates surrounded by a screen, and partly filled with steel balls. In this the clinker is reduced so far as to pass a twenty-mesh screen. The granulated clinker is then finished in tube mills, which consist of a steel cylinder about 22 feet long and 5 feet in diameter, lined with porcelain tiles, and nearly half filled with round flint pebbles. In this the granulated clinker is reduced to a powder of such fineness that 93 per cent. to 95 per cent. passes a sieve of 100 meshes to the linear inch. The tube mill is a very simple and effective machine and requires but slight repairs. The ball mill has, however, generally been found somewhat troublesome, and it is an open question whether the economy, in repairs and power, of the Griffin mill or the combined ball and tube mill system is the greater. An interesting machine to replace the ball mill has been lately introduced in this country; this is the Kent mill, which consists of a vertical revolving steel ring with three steel rollers held by springs against its inside surface. Tests lately made with this mill show its capacity and durability to be very great, and it is believed that this and the tube mill will constitute the most effectivesystem of grinding.



Clinker Stock House.

The use of Portland cement in all kinds of construction is extending with great rapidity. Cement concerete has replaced brick and stone almost completely for heavy foundations, bridge abutments and retaining walls. In combination with steel it is now extensively used for complete buildings and bridges. Hollow concrete building blocks, of cement and gravel, scarcely distinguishable from stone, are proving cheaper and better than brick for the construction of houses and factories. A multitude of new uses, such as for fence posts, piles, conduits, tiles and railway ties, are constantly coming into notice. It appears probable that the consumption of Portland cement in this country ten years from now may easily be twice or three times what it is at present. This will require the erection of a large number of new factories and great enlargement of existing works. Though the United States has now taken the first rank among the cement producing countries of the world, the industry must still be regarded as in it infancy. In all parts of the process improvement is not only possible but indispensible. This field offers, therefore, an unusual opportunity to the younger generation of engineers. Let us hope that America, the scene of the most rapid growth and greatest magnitude of Portland cement manufacture, may be entitled to the credit of bringing the industry to its highest state of economy and efficiency.

THE IMPROVEMENT OF THE PORTAGE LEVEE SYSTEM.*

BY PROF. LEONARD S. SMITH.

In order that the Portage Levee problem may be properly understood it will be necessary to call attention to the unique topography of the vicinity, which in several respects is not duplicated by the Wisconsin River at any other point of its course, or for that matter, by any other river in the state.

Briefly stated, that part of Portage City which lies west of the canal, and the country adjacent to it on the west, for perhaps three miles in extent, form a glacial island, bounded on the south by the swift waters of the Wisconsin River, on the north by the smaller and more sluggish waters of the Upper Fox, and on the west and east by low marshes sloping eastward with a considerable fall from the Wisconsin to the Fox River. The western marsh is traversed by a creek called the Big Slough, which in times of high water before the levees were built, was transformed into a mighty river, carrying the Wisconsin waters to the Fox, after having filled up and submerged tens of thousands of acres of the low intervening country.

It is a significant fact that in the years following the installation of the government dams at the outlet of Lake Winnebago, the United States paid out about a million of dollars for damages to owners of property in the Neenah and Fox River valleys, supposed to be caused by the holding back of the water, but as a matter of fact, *mainly due* to overflowing waters of the Wisconsin River through the marshes above described and especially through the Big Slough.

The intervening marsh on tbe east side of the Portage island and included between the Fox and Wisconsin rivers,

* The State Levee Commission having this work in charge is composed of John G. Standenmeyer, Herman Bellinghausen, and W. C. Gault.

has a minimum width of about one mile, in which distance the fall eastward toward the Fox is about three feet. The low water elevation of the Wisconsin River at this point is about eight feet higher than low water elevation of the Fox. But since the water of the Fox comes from the south, while that of the Wisconsin comes from the northern part of the state, it is inevitable that low water in the Fox often occurs at times of high water in the Wisconsin. At such times, as was the case in the spring and fall of 1900, as well as in September of 1903, the Wisconsin River water level may easily be 15 to 18 feet higher than that of the Fox. If, in addition to this fact it be remembered that the slope or fall of the Wisconsin in its own bed is only a foot to the mile, and that until 1882 no levees restricted its natural overflow, it is difficult to understand why Wisconsin's greatest river had not years ago broken across the narrow marsh which alone separated it from the Fox, and thus established its bed permanently with its smaller but more accommodating neighbor. From the standpoint of a topographer it is difficult to even see why the Wisconsin River should have ever in the beginning preferred the present to its more natural valley. It now flows at right angles to, instead of in, the direction of the normal to the slope of the surface.

Geologists claim that at the time of the readjustment of drainage systems which must have taken place at the close of the glacial period, the Wisconsin at this point found an old commodious river-bed provided for it by some preglacial river and thus found it easier to continue as a part of the Missisipi system than to make its own bed eastward and northward across the low divide, as a part of the St. Lawrence River system.

Certain it is that had the opportunity for the stronger river to overflow to the lower level been restricted to a few hundred feet instead of extending for *several* miles, the resulting overflow, because of its increased velocity, long ago would have worn a channel so deep as to permanently divert the Wisconsin River to the Fox River valley. It will be shown farther on in this paper that because of the changed regimen of the river, due to the levees already constructed, such a fundamental change may yet result, unless the levees are adequately strengthened.

As the valley of the Fox became settled up and highways and railroads were constructed, the periodic overflow of this region by the floods of the Wisconsin River became insuffera-

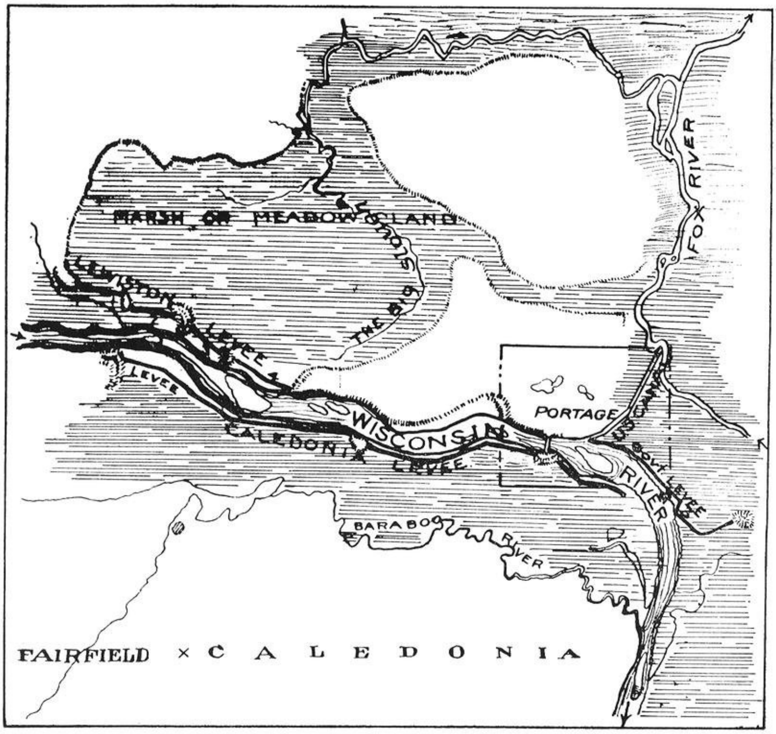


Fig. 1—Map of the Wisconsin River Levee at Portage and Vicinity.

ble, and small levees were built in 1861 at the most exposed places in the town of Lewiston.

The funds for these levees were provided by the sale of certain lands granted to the state by the United States under a general statute for reclaiming swamp lands.

These levees proved entirely inadequate at the times when the greatest protection was demanded, and during the high water of 1880–'81, they were swept away at several points, flooding the Fox River valley, from highland to highland, for a distance of nearly one hundred miles, inflicting vast damage to property and interrupting the running of trains on the C., M. & St. P. R. R. for a period of over a week.

The following year, in the expectation of preventing a recurrence of this disaster, the state appropriated $6,000, and

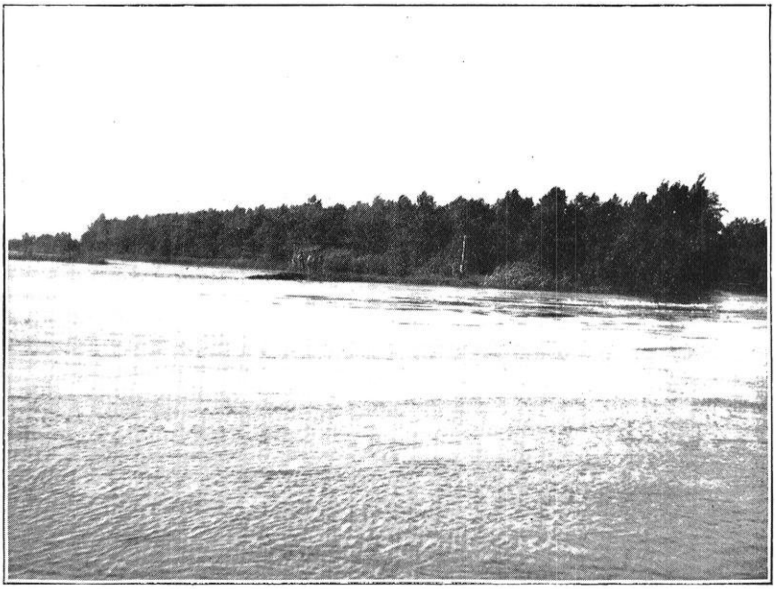


Fig. 2—Break in the Caledonia Levee, September, 1903.

the United States appropriated $3,000 for stronger levees on the north side of river and in the town of Lewiston. The town authorities have since added to some of these levees from time to time, notably along the section marked 4 (see plate 1), where a public road is maintained on the heel of the levee (land side).

As was feared at the time, the construction of this northern levee caused the flood waters to overflow on the opposite southern bank in the towns of Caledonia and Fairfield. Unfortunately the bottom lands at this point are very wide, extending even south of the Baraboo river, giving a strip of land varying in width from one to four miles wide and ten miles long, every inch of which now became submerged by flood waters, which formerly had been discharged into the Fox River.

Obviously a levee was the only protection possible, and an inadequate one was built in 1883. In spite of annual repairs

Fig. 3—Highway and Farmhouses Submerged by the Breaking of the Caledonia Levee in the City Limits of Portage.

and additions this levee is to-day the weakest of all the system, having suffered eight different crevasses, the last on the 20th, of last September.

The above picture shows the result of the last break in this south levee, about one-half mile west of bridge, and marked B, and in the city limits. The view is taken from the levee near the break and looks toward the south. Fortunately no loss of life resulted from this break, though at least in the one case of a lady and child driving on the submerged road, it was only through a most fortunate rescue that it was prevented. This road is shown in Fig. 3. For the same reason that the construction of the Lewiston levee threw the flood waters of the Wisconsin south onto the Caledonia low lands, so now the building of the Caledonia levees, especially that one just opposite the city of Portage, threw these same waters against the left bank of the river in the city, south of the canal and in the town of Pacific. This endangered not only the property of individuals, but also the entire system of the Federal river improvements, including the many costly

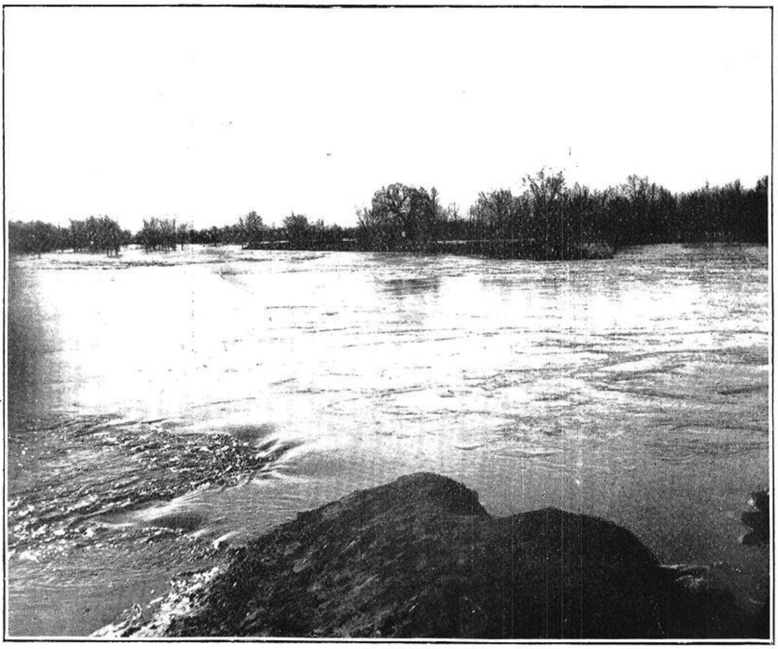


Fig. 4—View along Axis of the United States Government Levee Just South of Portage, Showing the Crevass Made by the Wisconsin River Flood of April, 1900.

locks and dams between Portage and Green Bay. That there was just cause for fear is seen in the effect of a small crevasse in the levee at this point in the spring of 1900, which after inundating the country for miles, overflowed into the canal with irresistible force, filling it with sand and mud, and washing out and completely destroying the lock at the entrance to the Fox River. Fig. 6 shows the water rushing through the break in the levee.

The Federal authorities were early alarmed at the prospect of such a mighty river overflowing into the canal and Fox River, and well they might be, for at high water, with a discharge of not less than 60,000 second feet, its powers were not to be despised. At the next session of congress, in 1886, money was appropriated and the present government levee constructed.

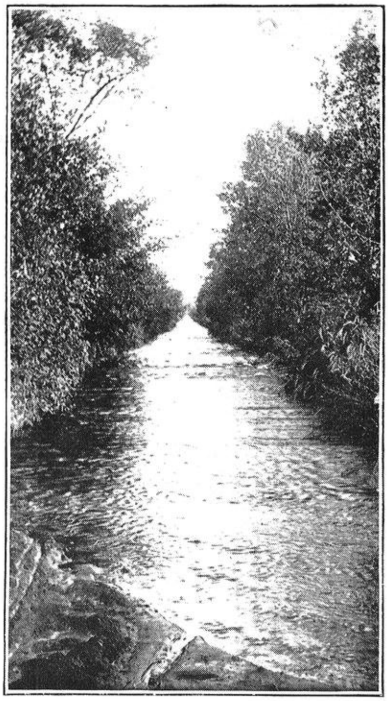


Fig. 5—Condition of Main Highway Leading East from Portage After the Break in the Government Levee, April, 1900.

That either poor judgment or jobbery (or perhaps both), figured in its construction only a cursory glance at its location, alignment and cross-section is necessary. Some of these faults are so typical of the entire system of twenty miles that a brief discussion of them here may not be out of place.

(1.) Location: The location of the levee so near the bank of the river is certainly not calculated to insure its permanancy for several reasons. The river at this point, and for perhaps two or more miles down stream is changing its course from easterly to a southern direction, a change which is made only at the expense of the bank on which the water impinges. As a result the river is surely if gradually encroaching on the levee, which, if unprotected by rip-rap means its certain ruin.

Fig. 6—View Along Cook Street, One of the Main Streets of Portage—Flood of Wisconsin River, April, 1900.

Another important reason for placing the levee further back from the river results from the tendency of all levees to raise the *high water level* by decreasing the cross-section of the stream. This tendency can be minimized by placing the levee at a sufficient distance from the river bank. In general it will be economical to build so as to provide an adequate cross-section; even if the actual levee is thereby lengthened, the levee prism will demand less embankment because of lower high water line. With a river whose present regimen is so well established as that of the Wisconsin, the problem of properly locating the lever would not be difficult. As already stated its high water discharge is close to 60,000 second feet. Assuming an average velocity of 6 feet per second, this would call for a stream cross-section of about 10,000 square feet. A topographic survey of the river and a study of high water marks would only be required to determine the location of the levee in order to give the requisite cross-section with most economical high water line.

(2) Alignment: The best alignment of a levee might be said to be more a matter of good judgment and common sense than of engineering were it not that good judgment and good engineering must mean in the last analysis the same thing. Common sense dictates that the levee should run parallel to the stream and not at right angles to it; that it should have as few and as small changes of direction as possible and that these changes in direction should be gradual and on a smooth curve.

And yet in the levee under discussion, the government levee, every one of these points is violated. A levee is like a chain —its strength is not that of its strongest but of its weakest link. Obviously the weakest point in this levee should be in the section marked a-b on the map. It was in this section that a break actually occured in the spring of 1900. Several thousand bags of sand were required at this point to hold the levee last September and it still remains a very weak structure.

A bill has been presented to the present congress appropriating a sum sufficient to reconstruct the levee which protects the eastern part of the city of Portage, the government canal and the four lines of railroad radiating therefrom, along the south side of the present turnpike leading east from the city. This will move the levee an average distance of 600 feet farther from the river and by thus increasing the cross-section of the river will lower the high water line. Another advantage of this location will be furnished by the solid bed of the turnpike at the heel of the levee, giving great solidity and reducing the seepage of the water through the levee.

As the $18,000 available for improving the Portage levee system is entirely inadequate to undertake, unaided, so great a task, it is greatly to be hoped that the national government will see the necessity and propriety of itself adequately strengthening this levee, which in fact is its own property, built on its own right of way, and for the specific purpose of protecting the government canal and locks.

If this move for Federal aid be unsuccessful, then the Levee Commission look to the two great railroad corporations whose roadbeds for several miles are protected from overflow of the Wisconsin River by the levee alone. Even if the track were not thereby washed out, the delay of all traffic, both passenger and freight, for a week or ten days, on the trunk line of even one great railroad, can only result in an immense loss, which in a single instance must greatly exceed the entire cost of building a secure levee. Such a delay actually occurred in 1900, caused by the breaking of this levee, and the levee is weaker to-day than it was then. It was only by the most strenuous efforts of a hundred men, working day and night, using thousands of bags of sand, that this levee was prevented from breaking at several points last September. Had the levee on the opposite bank of the river not broken at this time, it seems certain that it could not have been saved. U. S. Engineer Mann expressed the opinion to the writer, after going through the strain of this last dangerous flood, that this levee required its crown raised at least four feet with corresponding additions to its slopes. This would increase its present strength by more than one hundred per cent., as may be seen by reference to figure (7), which represents a typical section of present government levee and the proposed enlargement.

Since 1882 many millions of dollars have been spent for levee construction, principally on the Mississippi River, by both state and Federal authorities. As practically all of the work has been executed under the direction of civil engineers, the economics of levee building has been scientifically studied.* The proper size of cross-section of a water turning embankment In general, is a function of the kind of foundation, the available material, its method of construction, and the duration of time it is expected to protect against continuous high water.

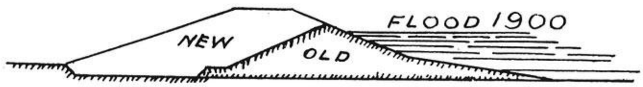


Fig. 7—Cross Section of the United States Levee and the Proposed New Addition to It.

The material usually met with in alluvial valleys is generally clay, sand and loam, usually much mixed. The sand is generally fine and smooth, and the clay silicious. The most impervious soil should be placed in the half facing the water. Sand, if used, should be placed on the land side, thus allowing any seepage from the river to readily drain away. If water be allowed to accumulate, the resulting hydraulic pressure would cause the levee to fail.

Sand forms the greater part of the bottom lands of the Wisconsin River, and as a result it is necessary that the levee be, in large part, made of this material. This fact, together with their inadequate cross section is responsible for most of their past failures.

That method of constructing a levee is best which insures the greastest and most uniform packing. This has been found to be secured by the use of wheel scrapers and the placing of the material in successive layers of two or three feet; wheel barrows should not be used.

Coming now to the last point to be considered in the construction of a water turning embankment, and one most fre-

*See valuable papers and discussions before the Am. Soc. of C. E. "Some notes on Holland Dykes," by Wm. Starling, Transactions Am. Soc. Civil Engrs., Vol. 26; Standard Levee Sections, Transactions, Vol. 39, and "The Levee Theory on the Mississippi River," Proceedings Am. Soc. C. E. Oct., 1903.

quently forgotten—the effect of the duration of high water. Its importance will be appreciated when it is noted that levees when guarded have most often failed, not by overtopping, but instead by their saturation. Obviously the time element is only second to the character of the material in determining the amount of saturation. The water gets into the embankment from two causes, first due to the hydrostatic pressure of impinging the water and increasing at the ratio of 62.5 pounds for each foot below the surface, and second because of the force of capillary attraction in the soil itself. The resultant of these two forces, together with gravity, cause the levee to become saturated deeper and deeper each day. As the first of these forces is a variable one, while the second is a constant for any given soil, the line between the dry and the saturated should be a curved one. By taking an average of a large number of actual tests the curve shown in figure 8 was obtained. *

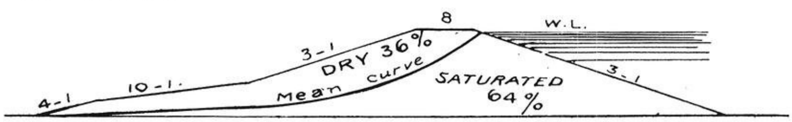


Fig. 8—Showing the Mean Curve of Saturation on Mississippi River Levees.

A small amount of seepage is to be expected and is not dangerous to the levee, but if the section be small or the pressure long continued the particles become semi-liquid and tend as such to obey the laws of liquids rather than that of solids. As a result the materials on the rear slough off, and the levee gradually fails. Unless aid is present at the first sign of such failure the levee is doomed, for a small failure of a foot or two quickly becomes a roaring torrent, utterly beyond control.

When the levee becomes dangerous by saturation, the section of dry earth still remaining above the saturation line, A B, instead of being a protection may actually be a source of failure. That is to say, its weight may cause the now

*Transactions Am. Soc. C. E., Vol. 39, page 236.

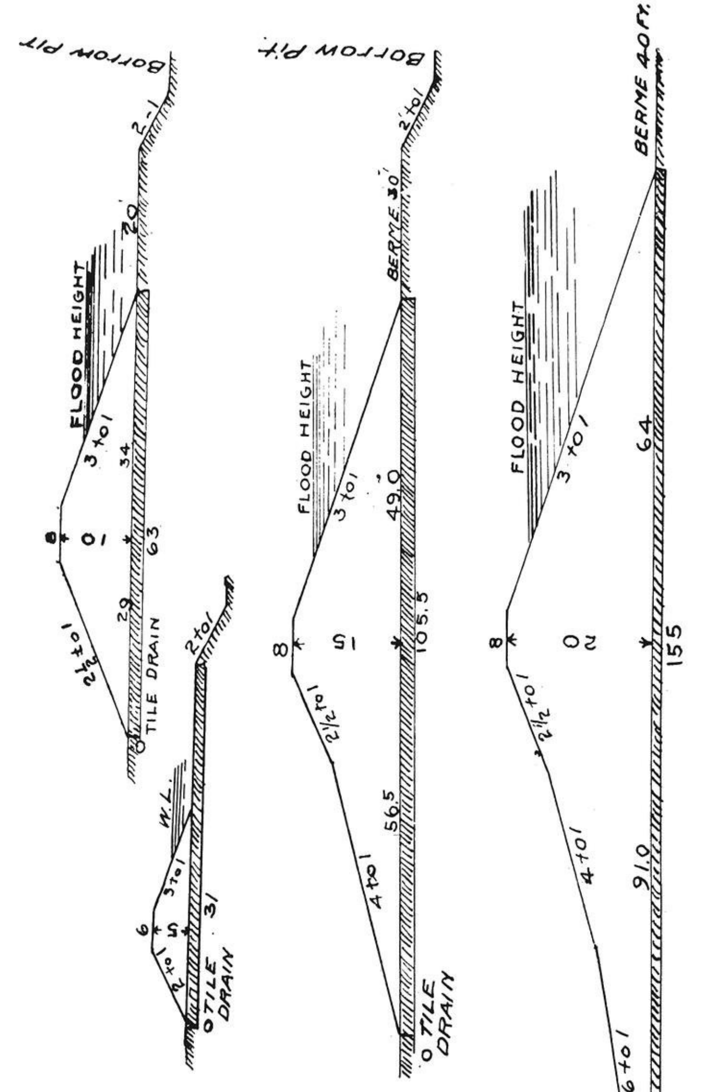


Fig. 9—Standard Cross-Sections of the Mississippi River Commission for Levee Heights of from 5 to 20 Feet.

nearly saturated portion to push or slough out, the line of fracture being nearly a vertical wall.

This tendency can be overcome to some extent in two ways, making the land portion of the levee of heavy but porous material, so that any water which may enter it from the river may readily escape without causing hydraulic pressure, and second by providing a trench at the land side base of the levee so that the back water may not accumulate, but instead, be readily drained off. A flat sloped banquette may also form a needed protection to this sloughing process and should never be omitted in levees exceeding 12 feet high.

The following are the standard cross-sections of the Mississippi River Commission: (See page 108).

Thinking that the specifications might be of interest as showing how the above cautions have been carried out by the writer, they are here given in full.

SPECIFICATIONS FOR CALEDONIA LEVEE.

OFFICE OF STATE LEVEE COMMISSION,
PORTAGE, WIS., Sept. 25, 1904.

General Instructions for Bidders.

1. Maps and profiles of the locality may be seen at the office. Bidders, or their agents, are expected to visit the place and make their own estimates of the facilities and difficulties attending the execution of the work.

2. No proposal will be considered unless accompanied by a guaranty as hereinafter provided.

3. Each guaranty will justify in the sum of 10 per cent of the sum total of the amount bid.

4. The place of residence of every bidder and postoffice address, with county and state must be given after his signature.

5. All prices must be written as well as expressed in figures.

6. One copy of these specifications (which may be obtained

by mail or in person of W. C. Gault, Sec'y, Portage, Wis.), must he attached to each bid and considered a part of the proposal.

7. The proposal and guaranty must be placed in a sealed envelope marked "Proposal For Levee Work" to be opened September 25, 1904, and enclosed in another sealed envelope, addressed to W. C. Gault, Sec'y, State Levee Commission.

8. The Commission reserves the right to reject any and all bids and to waive any informality in the bids received.

9. The bidder to whom award is made will be required to enter into a written contract with the State Levee Commission, with approved security in an amount of 10 per cent. of amount of the contract within in ten days after being notified of the acceptance of his proposal.

General Conditions.

10. A copy of these specifications and instructions will be attached to the contract and form a part of it.

11. The decision of the Engineer in charge as to quality and quantity of materials shall be final.

12. It is understood and agreed that the quantities given are approximate only, and it must be understood that no claim shall be made against this commission on account of any excess 'or deficiency, absolute or relative in the same. Bidders are expected to examine the drawings and are invited to make the estimates themselves.

13. Payments will be made monthly, based on the Engineer's estimates. A percentage of (10) ten per cent. will be reserved from each payment until the completion of the contract.

Specifications.

14. The work to be done under these specifications is the building of new levees and the enlarging of existing levee as indicated on the next page:

CALEDONIA LEVEE.

LOCATION.	CHARACTER OF WORK.	Approximate Yardage.
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....
....	....	....

15. The Levee Commission reserves the right to increase or diminish the above quantities.

16. Proposals will be received for the work in sections as indicated above and bidders are invited to bid on any or all sections. If any bidder proposes to construct more than one section, he will state the cubic yards he is prepared to accept. If he be the lowest bidder such sections as nearly contiguous as possible will be awarded him within the amount stated, as may be most advantageous to the state.

17. *Method of Constructing New Levees*—The ground to be occupied by the levee must be cleared of logs, trash, weeds, grass and leaves to the satisfaction of the Engineer in charge. Following this the surface between the slope stakes and to a depth of six inches shall be thoroughly broken, all trees, stumps and buried logs removed outside of the slope stakes. Wherever the Engineer may think necessary a muck ditch shall be cut of such dimensions and in such location as the Engineer shall direct. After inspection and measurement the muck ditch must be filled in with approved material procured without the base of the levee and thoroughly tamped while being filled. to the satisfaction of the Engineer. All the foregoing work shall be completed 200 feet in advance of the embankment. When this has been done, embankment construction shall be commenced and carried up to gross fill

or height as directed by the Engineer in charge. Special pains shall be taken to place as much of the best top or any clay soil excavated on the top and sides as possible.

18. *Method of Enlarging Old Levees*—In the raising and enlarging of old levees, the material shall be placed on the land side unless otherwise directed by the Engineer in charge. The portion of the old levee and the natural surface of the ground to be occupied by the new work will be prepared as described in section 17, for the base of new levees, and the surface to be occupied by the enlargement must be well broken. Except by special permission of the Engineer in charge given in writing, all old levees or parts of same must be left and the material for enlargement shall not be taken from any old borrow pits, but instead, on the natural ground on the side of said pits farthest from the levee.

19. *Obtaining Earth*—In procuring material for the levee the place will be designated by the Engineer in charge (on the land side unless otherwise directed) and care shall be taken not to exceed the limits of the right of way. The slope or the bank next to the levee must not be steeper than two base to one perpendicular and the borrow pit at this point shall not exceed three feet and at no point shall their depth exceed five feet. No material shall be taken nearer than 50 feet from the base of the levee and this distance shall be increased as far as the amount of material required and the limits of the right of way will allow. The Contractors will not be allowed to place earth on frozen surface nor will frozen earth, snow or ice be allowed in the levee. Such material must be wasted or work postponed.

20. *Stakes*—Stakes will be driven for the contractor by the Engineer giving width of crown and foot of slopes on the base and he will be held responsible for their preservation and for the embankment being constructed in exact accordance therewith.

21. *Shrinkage*—The usual allowance of 10 per cent. for settling or shrinkage of the embankment will be made and no embankment that is not carried up 10 per cent. higher

than the established grade will be paid for. The allowance for shrinkage must be so disposed on top and slopes as to give the required width of crown and to fill out the slopes so as to be plane surfaces from edge of crown to base of levee. The contents of the levee computed to the established net grade only will be paid for.

22. All damage to work for any cause shall, until the work is received by the Engineer in charge, be sustained by the contractor.

Force.

23. Within ten days after written notice has been given the contractor, he shall commence work and he shall at all times thereafter employ such force and outfit as shall in the opinion of the Levee Commission be necessary to complete the work within the contract time. In case the contractor does not comply with this provision the Levee Commission shall have the power to employ labor and additional outfit as may in their judgment seem necessary to complete the contract in the contract time and place them upon the work, deducting the total cost of same from the moneys due or to become due the contractor.

24. *Superintendence*—The contractor shall either personally superintend his work on the ground or cause it to be done by some capable representative who shall be satisfactory to the Engineer in charge. Where work is let to station men the contractor shall furnish a competent foreman to superintend their work and no foreman shall have charge of more men than the Engineer in charge deems advisable.

Extra Work.

25. No claim for extra work will be entertained unless such extra work is done under written instructions from the Engineer in charge, and these instructions must be presented with the claims.

26. *Change in Dimensions*—The Commission reserves the right to increase or diminish the height, crown or base of levee while in process of construction.

27. *Payments*—Payments will be made on monthly estimates of levee work fully completed.

28. *Disagreement*—In case of any doubt or disagreement arising under these specifications, the decision of the Engineer in charge shall be final, and he shall be the sole referee.

29. *Date of Completion*—The levee work shall be fully completed in accordance with these specifications on or before......................

Several bids were received on the above specifications, the lowest being eleven cents per cubic yard. No contracts were made because of the failure to secure right of way. This has now been secured and the work will be pushed as soon as the weather and ground conditions permit.

THE UNIVERSITY EXHIBIT AT THE LOUISIANA PURCHASE EXPOSITION.

BY J. G. D. MACK.*

In many, if not all of the "Worlds Fairs" of the past there has been a department in some building devoted to a so called Educational Exhibit.

The location of these exhibits may have given to the casual observer the impression that education follows the progress and development of a people.

The Louisiana Purchase Exposition which is to be held in St. Louis this year will have the first building ever erected at any exposition solely for educational exhibits.

In one of the general circulars published by the Exposition authorities this statement occurs.

"Education has been given first place among the departments of the Exposition in accordance with the theory upon which the entire organization is based, viz. that education is the source of all progress."

In addition to giving Education the place of honor among the departments by placing the educational exhibits in Group A, the building assigned to these exhibits occupies one of the most prominent sites.

The principle buildings are disposed in a fan shaped arrangement, the location of the Festival Hall corresponding with the pivot of the fan. Running out radially from the Festival Hall is the Grand Basin corresponding to the middle rib of the fan.

As the observer stands at the Festival Hall and looks along the Grand Basin the first building seen to the right of the latter is the Palace of Education, and across the Basin at the same radial distance from the Festival Hall is the Electricity Building.

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*Prof. Mack is chairman of the committee which has in charge the arranging of the university exhibit.

The Educational Building is a five sided structure of keystone shape, the northern facade being 750 feet in length, the southern 450 feet and the sides 525 feet each.

The building covers about seven acres and as originally designed was to have an open court in the centre. The demands for space have been so pressing, however, that it has been found necessary to roof over the court in order to provide additional exhibit space.

According to the first plans all of the Wisconsin educational exhibits were to be in one location but this arrangement was changed by the department and the State exhibit including all schools except the University has been assigned to a space twenty-seven by forty feet immediately to the left of the main south entrance.

The space, originally planned for an open court, will be occupied by the exhibits of the American and Foreign Universities and Colleges.

One-fourth of this space will be occupied by the following Universities: Wisconsin, Michigan, Cornell, Harvard, Yale, Princeton, Illinois, Johns-Hopkins, Columbia, St. Louis, Missouri, Chicago and Washington.

The Board of Regents have allowed four thousand dollars for the exhibit of the University of Wisconsin. Except for attendance this sum will be available for the preparation of the exhibit, as the State Committee will furnish the booth and pay transportation and erection charges.

It is intended that the exhibit, to be made by the University, shall show the following points, among others in so far as they can be represented for this purpose:

The growth of the University from the beginning, in numbers of students, faculty, and courses of study.

The growth in material equipment, as land, buildings, libraries, laboratories, etc.

Products manufactured in the laboratories and shops.

Apparatus designed for research and commercial purposes.

Various student activities such as the work of the literary societies, student publications and athletics.

The unique location and environment of the University will be a special feature of the exhibit.

Some of the points noted in the above outline, which are of statistical nature, will be shown by means of charts which are now in preparation.

The literary work of members of the faculty will be shown by a collection of publications which have appeared since the World's Fair of 1893.

As an illustration of laboratory equipment a model is being constructed of the steam laboratory on a scale of one inch to the foot.

This model will be fifty by seventy inches in size and will appear practically complete in all details. The engines and other apparatus are finished in dull nickel, giving a fair imitation of the allumi num finish used in the laboratory.

The general appearance of the campus and its surroundings will be shown by model, enlarged photographs and maps.

There will be about thirty photographs, twenty by thirty inches, showing views of the University buildings and interiors, scenes about Madison and along the drives, athletic events, etc.

The campus will be shown by means of a relief model to a scale of one foot equals five hundred.

This model will be about eight feet in length, extending from the east side of the Gymnasium to west of the Horticultural building, and will be built in all necessary details as regards buildings, trees and natural features of the grounds.

To form an idea of this scale the Library Building will be about five inches in length and the Law Building about two inches square.

A model of the Library Building has been considered, but not as yet definitely determined on.

The Historical Library will be shown in some manner, for the collections contained in this library have been of greater importance than any other factor in giving historical significance to the Louisiana Purchase.

It is a matter of no great difficulty to represent adequately, by an exhibit, matters of a statistical nature, features of location and laboratory equipment, but the humanities side is far more difficult of representation.

A matter of special pride to those interested in the University of Wisconsin is that a determined effort has been made, and successfuily, to maintain its different departments in as nearly equal strength as possible; one has not been allowed to grow beyond its immediate necessities at the expense of another.

It is a matter of the greatest importance that this policy should be shown in the exhibit by making the exhibit's four different departments of equal strength as nearly as possible.

This opportunity is taken advantage of to call attention to the fact that this exhibit is a matter in which every one connected with the University and all who are interested in it should be concerned, and any suggestions regarding the exhibit and means for making it represent the University in the best possible manner should be given to the committee having the matter in charge.

The writer has been asked the question many times as to whether this exhibit will pay, that is whether there will be any return proportionate to the expenditure. This is a phase of the matter which admits of no consideration, and it should not be discussed from this standpoint.

All of the great universities in this country, and some from abroad are to be represented, and the Exposition will be visited by many Wisconsin alumni and people of the state who have a pride in the University which would not be increased by learning that it alone of all the great American universities had no exhibit.

The Louisiana Purchase Exposition was designed primarily to show to the world the resources of the great middle west; and as already noted, education is given the place of honor.

The University, supported by the state, is the typical educational institution of this middle west, and from its position among the others, it is of the greatest importance that the University of Wisconsin be given adequate representation, although not one cent may ever be directly traced as coming from this exhibit.

INSPECTION TRIP OF SENIOR CIVILS.

The annual Inspection Trip of the Senior Civils was taken during the week of Dec. 17, 1903. It had been planned to take the trip earlier in the year, but for various reasons it was postponed until the week before the Christmas recess.

The party, consisting of Prof. Dufour, Mr. Williams and twelve students, arrived in Chicago, Thursday, Dec. 17th, at noon, and, after registering at the Victoria Hotel, started for the Lassig Plant of the American Bridge Company. We were furnished with a guide, who took us through the plant. We saw bridge members in all stages of construction from the time the material is taken from the stock pile until the finished piece is ready for shipment. In the first place wooden templates are made for each plate and angle showing the size of the piece and the exact location of the rivet holes. These templates are then taken to the iron shop and the exact size of the piece is laid out and the rivet holes located on the plate or angle, which is then taken to the shears and punches and is cut to the proper shape and the rivet holes are punched.

These punches and shears are very large and heavy machines, each one being operated by a separate electric motor. After the plates and angles have been made ready, they are all taken to the assembling floor and the bridge member is erected, the various parts being held together by drift pins and bolts. After everything is securely fastened, the rivets are then driven. This is done by pneumatic riveters, which are suspended from traveling cranes, and are moved to all parts of the member, as in the case of a large and heavy girder which could not be moved without great and powerful cranes. In fact much of the machinery is of such a nature that it can be moved to all parts of the work. This portable machinery is mostly driven by compressed air. After the members have been riveted up they are inspected and painted and are then taken to the shipping yard, and loaded on cars by powerful yard cranes.

The next morning we inspected a number of draw bridges in different parts of the city. Most of these bridges are old and out of date, and are fast being replaced by the rolling lift type of bridge, several of which we visited. These bridges consist of two leaves which are locked together at the center when the bridge is closed and form a three hinged arch. Each part is supported on pedestals, at the top of which are hinges. When the bridge is to be opened each arm rises around these hinges while the lower portion rolls upon the abutments. The great advantages of this type of bridge, are the speed with which they can be opened and closed, and the fact that they offer a clear water way from shore to shore, which makes them more desirable than the old swing bridges with their center pier in mid channel.

The Halsted St. lift bridge also offers a clear channel. Here this is effected by lifting the span vertically between high towers on each bank of the river. It is in fact a huge elevator having in place of the "cage" a bridge truss of 130 feet span, carrying foot passengers, vehicles and street cars across the river at this point. The vertical lift is 140 feet which gives a head room of 155 feet, or 20 feet more than the famous Brooklyn Bridge in New York City. The operator at the bridge gave our party a "lift", the round trip taking about five minutes. Operators at open bridges also opened their bridges for our benefit, as all of the bridges are opened several times each day to see that they are in condition for use at all times.

In the afternoon we visited the track elevation of the C. & W. I. Ry., which at present has been completed as far north as 47th street, and is being extended toward the city. The method employed in this work is to leave one or more of the tracks undisturbed, in order to carry the existing traffic, and to elevate the rest to the new level by building up the embankment and by carrying the tracks across the streets by means of temporary bridges. After this has been done, the traffic is then carried on the elevated tracks, and the others are then elevated to the same level, after which the temporary bridges are replaced by permanent bridges, usually of the plate girder type.

The Pennsylvania railway is elevating its tracks in this same locality, and we visited this work also. In addition to the elevation of the main lines, a new gravity classification yard is being built, in which all freight is to be classified and the trains made up.

A gravity classification yard, as its name indicates, is one in which the force of gravity is made use of. The cars are started down a short piece of steep grade and thus gain sufficient speed to carry them to any part of the yard, which is built on a slight down grade. In this way a switch engine can remain at one end of the yard, and in a short time can sort a long train of cars.

Saturday morning the unfavorable weather made sight-seeing very disagreeable. In spite of this we visited the 14th Street Pumping Station of the Chicago Water Works. This station contains four large vertical triple expansion pumping engines, ranging in capacity from 18,000,000 to 30,000,000 gallons per day. We went down into the pump pits, which extend about 40 feet below the street level. The boiler plant consists of twelve large boilers, only half of which are in use at a time. We also visited a near-by round house of the Pennylvania railway, where we saw the methods employed in coaling and cleaning the large locomotives. In the afternoon we visited the stock yards. One of the members of the party had a friend in the office of Swift & Co., and through him we obtained a special guide, who spent the afternoon showing us all parts of the plant.

Next plant visited was the Pullman Car Shops at Pullman, in which we spent Monday morning, accompanied by two guides. We first visited the blacksmith shop, where the car axles and other heavy pieces are forged. This is done by means of large steam hammers. The smaller forgings are made by power hammers. We then passed to the carpenter shops, in which we saw parlor cars in all stages of construction, from the framing until the car is finished and ready for use. An exhibi tion train was being built, but the cars had just been framed, so that we could not get much of an idea of their final appearance.

In the afternoon we visited the South Chicago plant of the Illinois Steel Co. We were only able to see a small part of the plant in operation, as the plate and shape mills were not running. This plant is very large, covering about 260 acres of land, and containing abut 150 buildings of all kinds. About 40 miles of railroad tracks connect the various parts of the yard and render rapid transportation of material possible.

The ore is brought from the docks, near the lake shore, to the blast furnaces, by means of buckets and conveyors, and here the crude ore is reduced to the metal, which comes out in the shape of molten iron. The waste gases from the blast furnaces are used for heating the air blast and also as fuel under the boilers which furnish the steam for the air blast engines.

The molten metal is taken by trains of ladle cars to the Bessemer and open hearth plants where it is made into steel. In the Bessemer process the molten iron is placed in a converter and by means of an air blast the carbon is burned out of the iron, after which an amount of spiegeleisen is added which will give the steel a required carbon content.

This process is very spectacular and is accompanied by intensely bright carbon flames and showers of sparks. After the process is completed the molten steel is cast into ingots, which are taken to the rail mill and are then rolled into rails.

The rolls used are operated by very powerful engines and the huge ingots are handled with great speed, twenty-two passes being required to change the ingots, which are about eighteen inches square and six feet long, into steel rails thirty feet long, each ingot making six rails. In the open hearth process the steel is made in a reverbatory furnace. The steel made here has a smaller content of carbon than the Bessemer steel and is used for structural shapes, etc., when great tensile strength is required.

This steel is also cast into ingots which are rolled into plates and shapes. As the plate and shape mills were not running, these ingots were made into billets about six inches square and five feet long.

On Tuesday we inspected the Drainage Canal.

We went to Lockport via the Sante Fe, whose tracks run very close to the canal. The object of this canal is to carry the sewerage of Chicago away from Lake Michigan, the source of Chicago's water supply, and also to open up a direct water connection between Chicago and the Mississippi River. The canal is about thirty miles long, extending from the South Branch of the Chicago River in a southwesterly direction to Lockport. At Lockport the canal empties into the Desplaines River, a tributary of the Illinois River, which flows into the Mississippi just above St. Louis. The general cross-section of the canal is about 200 feet wide in the base and, when carrying its intended capacity of 600,000 cu. ft. per minute, has a depth of twenty-two feet of water, which will float the largest lake steamers. At Lockport is located the controlling works by means of which the amount of water flowing from the canal into the Desplaines River is regulated. These works consist of sluice gates and a bear trap dam, whose crest can be raised or lowered, thus regulating the amount of water passing over the top of the dam. This is done by the water pressure acting on the under side of the dam and is controlled by a set of valves.

In this way the amount of water flowing from the lake into the river is always under control. A power plant of about 30,000 H. P. is now being built at Lockport. At Joliet, about six miles from Lockport, is a large electric power plant which furnishes the power for the Chicago-Joliet street car line. After inspecting the works at Lockport the party went to Joliet and inspected the plant, which is driven by the water power obtained from the Desplaines River.

On Wednesday the party was taken out to several of the water supply cribs upon the city tug. This was made possible by Mr. John Erickson, until recently city engineer of

Chicago, who, while lecturing before the College of Engineering a year ago, offered to take any Wisconsin University students out to the cribs should they care to make the trip when in Chicago. When reminded of this promise by members of the party, he very kindly complied by putting the city tug at the disposal of the party. These cribs are large protected intake pipes situated from three to five miles out in the lake in order to obtain a supply of pure water. They are connected to the shore by means of tunnels which lead to the various pumping stations in the city.

This trip ended the tour of inspection and most of the party returned to Madison at once.

W. S. KINNE, '04.

The Wisconsin Engineer.

Published Quarterly by the Students of the College of Engineering, University of Wisconsin.

Vol. 8. Madison, Wis., February, 1904. No. 2

TERMS:

$1.00 if paid before February 1st; after that date, $1.50. Single copies, 35c.
Entered in the postoffice at Madison as matter of the second class.

The recent selection by the Board of Regents of Professor Frederick E. Turneaure for the important position of Dean of the College of Engineering, it is needless to say, meets with the most cordial approval of all engineering students and the faculty of the college. Since the death of his predecessor, the late Dean Johnson, Professor Turneaure has been called upon to assume the executive duties of the College. In the capacity of Acting Dean, a position entailing all the responsibility without the actual authority of the position, he has encountered and wisely solved, problems resulting from an unprecedented growth of the College and consequent lack of room in the building. These and other problems he has met with the same quiet force and efficiency which have characterized his entire connection with the University. In another column we give a sketch of the Dean by Professor J. G. D. Mack, who is well fitted to speak of his connection with theUniversity, by reason of his own long service here.

The growth of the College has been of extraordinary rapidity during the past few years, and its future is a momentous one. We are confident that its best possibilities will be realized under the guidance of Dean Turneaure.

The editorial board takes pleasure in announcing the election, as Associate Editors of THE ENGINEER the following members of the faculty: W. D. Taylor, C. E., Professor of Railway Engineering; D. C. Jackson, C. E., Professor of Electrical Engineering, and J. G. D. Mack, M. E., Professor of Machine Design, representing the three departments of the College, namely, civil, electrical and mechanical engineering. Professors Jackson, Taylor and Mack have always shown a kindly interest in THE ENGINEER and we are confident that their more intimate connection with the journal, in the capacity of advisory members of the literary staff, will contribute much to its prosperity, literary and technical quality. It is not the purpose of the board of editors to make THE ENGINEER any the less a student publication, but rather to give the editors the benefit of a closer association with practical engineers in the selection of material for its readers.

The position of Graduate Editor, which has been vacant since the beginning of the year, has been filled by the election of Mr. Alvin Haase, B. S. C. E., '03. Mr. Haase was editor-in-chief of THE ENGINEER during his senior year and is now an assistant in Experimental Engineering, in charge of the testing laboratory.

With this issue of the ENGINEER we are giving a revised directory of the alumni of the College of Engineering. Although necessarily somewhat incomplete, it represents a systematic and conscientious effort to secure correct information concerning the present addresses of the graduates. During the past semester, Dean Turneaure has interested himself in the matter of revising the directory, and a large number of personal letters have been sent out with this end in view. He has also been assisted in the work by the Alumni Editor of the ENGINEER.

All readers of the ENGINEER are earnestly requested to co-operate with the Dean and the editors, by examining the directory carefully and noting any corrections or additions. These may be sent to the Dean or to the Alumni Editor of the WISCONSIN ENGINEER, and will be given proper attention. The directory will be published again this year in the June number of this magazine, and also in the *College of Engineering Circular* to be issued some time during the present semester.

NOTES AND PERSONALS.

The two booklets, "A Few Facts About Astronomy" and "The Possibilities of this Life," by Samuel Harris, sent us with the compliments of the Samuel Harris Company, of Chicago, are both interesting and valuable reading.

Through the kindness of the Vilter Mfg. Co. of Milwaukee, the department of Experimental Engineering has just received a set of apparatus permitting the weighing of the liquid ammonia passing through the ammonia compressor of the refrigerating plant.

Prof. A. W. Richter received a letter during the past week from Mr. A. S. White, of Cleveland, Ohio, stating that complete models of the White condensers, recently installed in our steam laboratory, in connection with the Vilter refrigerating plant, have been shipped to St. Louis to be exhibited at the Louisiana Purchase Exposition.

THE ENGINEER is in receipt of a copy of the desk calendar sent out by the Pope Mfg. Co., of Hartford, Conn., announcing that Col. Albert A. Pope, the founder of the bicycle industry in this country is once more at the head of this industry. Readers of THE ENGINEER may secure this popular daily memorandum, by sending five two cent stamps to the Pope Mfg. Co., Hartford, Conn.

A number of the seniors in the Civil Engineering Course have received copies of *Gurley's Manual*, now recognized as a standard treatise on all kinds of engineers' and surveyors' inst ruments, with the compliments of W. & L. E. Gurley, of Troy, N. Y. The manual is a valuable book of nearly five hundred pages and profusely illustrated. It may be obtained by sending a request to the home office at Troy, N. Y.

Through the courtesy of Mr. S. B. Newberry, manager of the Sandusky Portland Cement Company of Sandusky, Ohio, the ENGINEER is enabled to give its readers an excellent article on the manufacture of Portland cement from an engineering standpoint, covering the main points of the very interesting lecture on this topic delivered by Mr. Newberry before the engineering students on January 12th. The address was given without notes or manuscript, but at the request of the ENGINEER, Mr. Newberry consented to dictate a synopsis of his address on his return to Sandusky. For the cuts illustrating the article we are indebted to Mr. Wm. Seafert, editor of *Cement and Engineering News*, of Chicago.

Mr. T. L. C ondron, Consulting Engineer, of Chicago, delivered a very interesting lecture on "Reinforced Concrete," in the auditorium of the Engineer building, Friday afternoon, February 12. The lecture consisted of a report upon a series of tests of large steel-concrete beams, designed according to the formula derived by A. L. Johnson, of St. Louis, a brother of the late Dean Johnson. The lecture was well illustrated with lantern slides, showing photographs of the testing apparatus used, also the strength curves of the beams, and of the beams themselves before and after failure. Although the concrete used in the beams was considerably inferior to the standard concrete for which the Johnson formula was derived, yet the tests developed a strength greater than the theoretical strength where the reinforcing steel was distributed in smaller rods, and only about 5 per cent. less than the theoretical strength where larger rods were used. Concrete-steel construction offers an attractive field for investigation at the present time, and Mr. Condron's address served to give a very good idea of some of the things that are being done along this line outside of college laboratories.

THE ELECTRIC CLUB OF PITTSBURG.

THE ENGINEER is in receipt of an attractive brochure, descriptive of the Electric Club, of Pittsburg, Pa., an organization composed of the apprentices of the Westinghouse Electric & Manufacturing Company of that city. These young men by reason of their supplementary work in connection with the club enjoy exceptional opportunities for practical post graduate study in electrical engineering, most of them being graduates of technical schools. In the present enrollment are a number of Wisconsin graduates who are in the employ of the Westinghouse company, and by their invitation members of the present senior class who visited Pittsburg on the fall inspection trip, spent a very pleasant evening at the headquarters of the club.

The engineering apprentice makes the Electric Club supplement, in a general way, his shop work, in much the same manner that laboratory and shop practice in colleges supplement the theory of the text book and the lecture room. Under the direction of various committees, the older engineers are by a systematic plan brought into service for lectures and talks; and there are discussions among the young engineers themselves. There is a general lecture each week and there are numerous minor meetings of small engineering societies, or sections as they are termed, each having a definite subject, a particular leader, and bi-weekly meetings.

The club enrolls others besides engineering apprentices. There are men from high schools, men who have had a year or two at college or perhaps a still longer service in some school of experience; there are ambitious young men from various departments of the works; there are shop foremen and men from the testing departments, engineers who have recently emerged from apprenticeship and engineers who are older—though all are young men still—and others of the Electric Company, together with men from other Westinghouse companies.

In addition to its engineering work, the club affords opportunities for the social entertainment of its members by dances, whist and chess clubs, an orchestra, and athletic teams. The club is organized under the direct patronage of the Westinghouse company, which encourages its employes in every way possible to continue their scientific and theoretical work begun in the schools, along with the practical commercial work which the shops afford.

NEW PATENTS.

745,349. ENGINE-GOVERNOR. EDWARD M. HEWLETT, Schenectady, N. Y., assignor to General Electric Company, a corporation of New York. Filed May 31, 1891. Serial No. 62,624. (No model)

The combination of a centrifugal governor, an adjustable counterbalancet herefor, an electrically-operated motor mounted on the counterbalanee-arm to oppose by its weight the effect of the counterbalance, and means operated by the motor for varying the value of the counterbalance.

746,186. STEAM-BOILER. JAMES P. SNEDDON, Barberton, Ohio, assignor to the Stirling Company, Chicago, Ill., a Corporation of New Jersey. Filed Feb. 25, 1903. Serial No. 145,048. (No model.)

An element for a sectional steam-generator comprising a vertical header divided longitudinally into two chambers, a short vertical header opposite the lower end thereof, a series of water-tubes connecting said headers, some of said tubes communicating with one of the chambers in the divided header and the remainder of said tubes communicating with the other chamber in said divided header, and other water-tubes connected to said divided header and comprising outer tubes communicating with one of the chambers in said header and having their outer ends closed, and inner open-ended tubes communicating with the other chamber in said header projecting into the outer tubes.

747,109. CORLISS VALVE-GEAR FOR STEAM-ENGINES. WILLIAM WRIGHT, Brooklyn, N. Y.; Mary E. Wright administratrix of said William Wright, deceased. Filed Aug. 9, 1902. Renewed Nov. 13, 1903. Serial No. 181,097. (No model.)

The latch mechanism is transferred from the bell-cranks to the wrist plate. The bell-crank links of the admission valves are attached to false wrist plates which are moved by the wrist plate through latches. The governor releases the latch when the dashpot draws the false wrist plate back and so closes the valve again.

747,908. APPARATUS FOR CONTROLLING THE SUPPLY OF FEED-WATER TO STEAM-BOILERS. HENRY A. FLEUSS, Staines, England, assignor, to Fleuss Patent Automatic Boiler Feed and Motor Car Syndicate, Limited, London, England. Filed March 30, 1903. Serial No. 150,284. (No model.)

Consists of a tube which fills with water when the water level is high enough. When the water falls it fills with steam and the heat expands it and so operates the mechanism.

747,926 MULTIPLE-CYLINDER STEAM-ENGINE. HENRY S. BALDWIN, Lynn, Mass., assignor, by mesne assignments, to General Electric Company, a Corporation of New York. Filed June 1, 1903. Serial No. 159,483. (No model.)

Single acting cylinders arranged parallel to the main shaft. The piston rods connect to crossheads which also move parallel to the shaft and connecting rods connect to the arms of a wabbler pivoted on a ball and socket joint. The wabbler connects to and drives the shaft by a crank on the latter. The valves are poppet valves moved by cams on the main shaft.

747,927. EXHAUST-RELIEF FOR STEAM-VEHICLES. AUGUSTUS A. BALL, Jr., Lynn, Mass., assignor, by mesne assignments, to General Electric Company, a Corporation of New York. Filed June 8, 1903. Serial No. 160,462. (No model.)

In combination, a boiler normally working under natural draft, a burner, an engine, a condenser, arranged to receive the exhaust from the engine, a relief-valve in the condenser system which opens when the volume of steam delivered by the engine exceeds the capacity of the condenser, and a conduit which receives the exhaust from the relief-valve and discharges it in a manner to increase the draft on the burner.

ALUMNI DIRECTORY.

The Alumni Directory given below is as near complete as we can make it with our present information. In this we have been assisted by Dean F. E. Turneaure, who is revising and completing an Alumni Directory for the catalogue of the College of Engineering, and who gave us free access to his information as far as he had collected the same. However, neither the Dean nor the WISCONSIN ENGINEER has been able to obtain the correct addresses of all the Alumni. Those which are doubtful or unknown are marked with asterisks (*). A directory to be of any value must be complete and correct. We can do no more than we have done without further help from the Alumni. It is therefore of imperative necessity that the Alumni do all they can to keep us informed. Any information will be of equal value to this and the catalogue directory. This directory will be published again in a later number and in order to have it complete and correct all information must be sent in immediately.

Abbott, Clarence E., B. S. M. E., '01, 433 Murray St., Madison, Wis.

Adams, B. C., B. S. E. E. '03, Madison, Wis., Madison Gas and Electric Co.

*Adams, Bertram F., B. S. M. E., '02.

Adams, W. K., 6405 Stewart Ave., Chicago, Ill.

Adamson, Wm. H., B. S. C. E., '86, Seattle, Wash., Draftsman.

Ahara, Edwin H., B. S. C. E., '92; M. E., '96, Mishawaka, Ind., Supt. of Dodge Mfg. Co.

Ahara, Geo. V., B. S. M. E., '95, 1020 Oak St., Beloit, Wis., With Fairbanks, Morse & Co.

Ahara, Theo. H., B. S. M. E., '00, Williamsport, Pa., Williamsport Staple Co.

*Albers, John F., B. S. C. E., '77; C. E., '78, Antigo, Wis., Druggist.

Alexander, Walter B., B. S. M. E., '97, Minneapolis, Minn., Asst. Mast. Mech., care of C. M. & St. P. Ry.

Allen, Andrews B., B. S. C. E., '91, 1022 Monadnock Bldg., Chicago, Ill., Wisconsin Bridge Co.

Allen, John S., B. S. E. E., '97, Beloit, Wis., Mgr. Beloit Electric Light Co.

Alverson, Harry B., B. S. E. E., '93, 40 Court St., Buffalo, N. Y., Cataract Power & Conduit Co.

Anderson, A. E., B. S. M. E., '03, 818 Lincoln Ave., Schenectady, N. Y. General Electric Co.

Anderson, Gustave A., B. S. M. E., '02, 367 Jackson Blvd., Chicago, Ill.

*Arms, Richard M., B. S. E. E., '94.

Aston, Jas. B., B. S. E. E., '98, 1042 National Ave., Milwaukee, Wis., care of Thomas Aston & Son.

Atkins, Hubbard C., B, S. M. E., '01, Milwaukee, Wis., Allis-Chalmers Co.

*Austin, W. A., B. S. M. E., '99.

Baehr, Wm. A., B. S. C. E., '84, St. Louis, Mo., Engr. for La Clede Gas Co.

Bailey, H. E., B. S. E. E., '03, 2 Eagle St., Schenectady, N. Y., General Elect. Co.

Baldwin, Geo. W., B. S. C. E., '85, Crete, Neb., Lumber Dealer.

*Bamford, F. E., B. S. M. E., '87, Atlanta, Ga., Lieut. U. S. A.

Barnes, Chas. B., B. S. M. E., '00, 200 Oakwood Blvd., Chicago, Ill., Engineering Dept. Sargent & Lundy.

*Barr, J. M., B. S. M. E., '99.

Bassett, Henry Smith, C. E., '71, Preston, Minn., Lawyer.

Bauss, Richard E., B. S. M. E., '00, Pittsburg, Pa., Western Elec. Co.

*Bachelder, Clare H., B. S. M. E., '01.

Balsley, Eugene A., B. S. C. E., '02, Chicago, Ill., American Bridge Co.

Barkhausen, Louis H., B. S. M. E., '01, Racine, Wis., J. I. Case Co.

Bebb, Edward C., B. S. C. E., '96, Washington, D. C., U. S. Geol. Survey.

Beebe, Murray C., B. S. E. E., '97, Pittsburg, Pa., Nernst Lamp Co.

Belling, J. W., B. S. E. E., '03, Schenectady, N. Y., General Electric Co.

Bennett, Chas. W., B. S. M. E., '92, Elwood, Ind., American Tin Plate Co.

Benson, F. H., B. S. C. E., '91, New Insurance Bldg., Milwaukee, Wis.

Bently, F. W., B. S. M. E,. '98, 153 La Salle St., Chicago, Ill., Prin. Manual Training Dept. Association College.

Berg, William C., B. S. C. E., '02, died 1903.

Bergenthal, V. W., B. S. E. E., '97, Chicago, Ill., 5808 S. Park Ave., Automatic Switch and Signal Co.

Bertke, W. J., B. S. E. E., '03, Sioux City, Iowa, Souix City Gas and Electric Co.

Bertrand, Phil. A., B. S. E. E., '95, Springfield, Mo.
Berry, Claude, B. S. C. E., '01, 2854 Minnehaha Ave., Minneapolis, Minn., Struct. Engr. Minn. Steel and Mch. Co.
Biefeld, Paul A., B. S. E. E., '94, Prof. of Elec. Eng. School of Heilperghausen, Ger.
Bird, Henry, B. S. C. E., '94, died Dec. 22, '01.
Bird, Hobart S., B. S. C. E., '94; LL. B., '96, San Juan, Porto Rico.
*Bliss, Wm. S., B. S. M. E., '80, Williams, Arizona, J. M. Dennis Lumber Co.
Boardman, Harry B., B. S. E. E., '93, New York City.
Boardman, Horace P., B. S. C. E., '94, Milwaukee, Wis., Merrill Park Depot.
*Bohan, Wm. J., B. S. E. E., '95.
Boldenweck, Felix W., B. S. M. E., '02, 27 Stratford Place, Chicago, Ill., Testing Dept. Western Elec. Co.
Boley, C. U., B. S. C. E., '83; C. E., '99, Sheboygan Wis., City Engineer.
Boorse, Jesse M., B. S. E. E., '95, 721 S. Willow Ave., Austin, Ill.
Bossert, Chas. P., B. S. M. E., '88, 179 36th St., Mlwaukee, Wis., Pfister & Vogel Leather Co.
Boynton, C. W., B. S. M. E., '98, Sedro-Woolley, Skagit Co., Wash.
Brace, Jas. H., B. S. C. E., '92, 225 W. 33rd St., New York City, Engineer P. N. Y. & L. I. R'y.
Bradish, Geo. B., B. S. C. E., '76; C. E., '78, La Crosse, Wis., Civil Engineer.
*Bradley, Wm. H., B. S. C. E., '78, Mingo Junction Ohio, Junction Iron and Steel Co.
Brandt, Hugo W., B. S. C. E., '03, Madison, Wis., Ass't Engineer, State Board Assesment.
Brennan, Wm. M., B. S. C. E., '94, Cato, Manitowoc Co., Wisconsin, Ass't Engr. Wis. Central Ry.
Brobst, J. E., B. S. E. E., '03, Schenectady, N. Y., General Elect. Co.
*Broenniman, Arnold E., B. S. C. E., '97.
Brown, Geo. W., B. S. C. E., '86; C. E., '90, Tortugas, Monroe Co., Fla., Gov. Works.
Brown, L. R., B. S. E. E., '03, Schenectady, N. Y , General Elect. Co.
Brown, Perry F., B. S. C. E., '97, 412 E. 23d St., Oakland, Cal., City Engineer, Oakland, Cal.
Brown, Samuel L., B. S. M. E., '89, Tacoma, Wash., Tacoma Smelting Co.
Brown, Thane R., B. S. C. E., '95, box L, No. Milwaukee, Wis., Wis. Bridge & Iron Co.
Burdick, Wm. C., B. S. C. E., '01, 1015 Sycamore St., Milwaukee, Wis., St. Paul Depot,
Buerstatte, F. W., B. S. M. E., '01, 1440 Park Ave., Chicago, Ill., C. & N. W. R'y.
Bucey, John H., B. S. C. E., '95, died Dec. 4, 1896.
*Buckley, W. J., B. S. E. E., '99.
Bump, Milan R., B. S. E. E., '02, 620 Langdon St., Madison, Wis., Graduate, University of Wisconsin.

Burgess, Chas. F., B. S. E. E., '95, University of Wisconsin, Ass'st Prof. of Elec. Eng.
Burgess, Geo. H., B. S. C. E., '95, Pittsburg, Pa., Penn. Lines Chief Engineer's Office.
Burkholder, Chas. I., B. S. E. E., '96, Schenectady, N. Y., Gen. Elec. Co.
Burton, Wm. C., B. S. E. E., '93, 22 A, College Hill, Cannon St., London, Eng., J. G. White & Co., Limited.
Buttles, Ben. E., B. S. E. E., '00, 1260 Old Colony Bldg., Chicago, Ill.,
Cadby, J. N., B. S. E. E., '03, 601 S. Few St., Madison, Wis., Northern Elec. Co.
*Campbell, Bert, B. S. E. E., '98, Chicago, Ill.
Carey, Jas. L., B. S. M. E., '88, 306 Baird Ave., Austin Station, Chicago, Ill., Amer. Strawboard Co.
Carlsen, Chas. J., B. S. M. E., '96, River Forest, Ill., Elect. Engineer.
Carpenter, Chas. G., B. S. C. E., '82, City Hall, Milwaukee, Wis., Park Sup't.
Carter, B. B., B. S. M. E., '88, 1644 Monadnock Bldg., Chicago, Ill.
Caverno, Xenophon, B. S. M. E., '90, Kewaunee, Ill., Kewaunee Gas Light & Coke Co.
Clausen, Leon R., B. S. E. E., '97, Milwaukee, Wis., Chief Signal Engineer, C., M. & St. P. R'y.
Cochran, Rob't B., B. S. M. E., '97, St. James Park, Rochester, N. Y., Cochran-Bly Machine Works.
*Cole, Chas. M., B. S. M. E., '02.
Cole, Harry W., B. S. M. E., '02, Milwaukee, Wis., Allis-Chalmers Co.
*Colby, L. W., Beatrice, Neb.
Comstock, Nathan, B. S. M. E., '97, Arcadia, Wis., Attorney.
Connor, S. P., 301 W. 57th St., New York, N. Y.
Connolly, Pat. H., B. S. C. E., '85, Racine, Wis., City Engineer.
Conover, Allen D., Ph. B. C. E., 75, 151 W. Gilman St., Madison, Wis., Architect.
*Conradson, C. M., B. S. M. E., '83; M. E., '85.
Cook, Thomas R., B. S. M. E., '00, 421 E. Berry St., Fort Wayne, Ind., Penn. R'y Lines.
Coombs, Ed. C., B. S. C. E., '97, 310 Madison, St., Madison, Wis.
Cooper, A. S., B. S. C. E., '81; C. E., '83, Savannah, Ga., U. S. Ass't Engineer.
Cosgrove, J. F., E. E., '96, 919 Pine St., Scranton, Pa., Scranton Correspondence School.
Cornish, Ross C., B. S. C. E., '97, Milwaukee, Wis., 1st Ass't Sup't Milw. Gas Light Co.
Cowie, H. J., B. S. C. E., '03, Niagara Falls South, Ontario, Ontario Const. Co.
Crandall, H. R., B. S. M. E., '98, 180 23d St., Milwaukee, Wis.
Crane, Edgar W., B. S. E. E., '95, Orizaba, Mexico.
Crenshaw, Thos. P., B. S. E. E., '95, died.
Crowell, Robinson, E. E., '96, Sacramento, Cal., Sacramento Elec., Gas & Ry. Co.

Curtis, Norman P., B. S. C. E., '01, Madison, Wis.
Dean, Chas. L., B. S. M. E., '01, 917 S. 10th St., Lincoln, Neb., University of Nebraska.
Dean, G. C., B. S. M. E., '03, Milwaukee, Wis., Nordberg Mfg. Co.
Dean, J. S., B. S. M. E., '03.
De Lay, Frederic A., B. S. E. E., '02, Lock Box, 369, Houghton, Mich. Instructor Mich. School of Mines.
Diehl, Guy E., B. S. C. E., '02, Hibbing, Minn., U. S. Steel Corp.
*Dixon, Fred. B., B. S. C. E., '97, New London, Wis.
Dixon, John E., B. S. M. E., '00, 68 4th St., Dunkirk, N. Y., Brooks Locomotive Works.
Dodge, Jos., B. S. M. E., '84, 707 Women's Temple, Chicago, Ill., Western Agent, J. R. Kein & Co.
*Dodge, McClellan, B. S. C. E., '84, Eau Claire, Wis., City Engineer.
Douglass, C. C., B. S. M. E., '03, 502 Summit Ave., Schenectndy, N. Y,. General Elec. Co.
Dousman, Jas. H., B. S. C. E., '84, 73 31st St., Milwaukee, Wis., General Practice.
Dow, Herbert W., B. S. M. E., '02, Room 402, Engineering Hall, Ames, Iowa, Instructor, Iowa Agri. College.
Duffy, Wm. F., B. S. C. E., '84, Montgomery, La., Ass 't Engineer S. & R. B. V. Ry.
Durand, Samuel B., B. S. C. E., '91; C. E., Stanf ord, '94, died at Denver, Col., Oct. 29, 1900.
*Dutcher, John E., B. S. E. E. '97.
Earle, Roy R., B. S. E. E., '02, Schenectady, N. Y., General Elec. Co.
Earll, C. I., B. S. M. E., '85, 76 Williams St., New York City, Consulting Mech. Engineer.
*Egan, R. A., B. S. C. E., '99, Brooklyn, N. Y.
Ehreke, G. W. R., B. S. E. E., '02., 917 State St., Schenectady, N. Y., General Elec. Co.
Ehrnbeck, Anton D., B. S. C. E., '02, 22 34th St., Milwaukee, Wis., Merrill Park Depot, C., M. & St. P. Ry.
Ekern, E. A., B. S. E. E., '03, 502 N. Aurora St., Ithaca, N. Y., Fellow, Cornell University.
Ela, Edwin S, B. S. C. E., '96, Washington, D. C., Topographer U. S. G. S.
Elliott, H. S., B. S. E. E., '03, Helena, Mont., Mo. River Power Co.
Ellis, John F., B. S. C. E., '87,, died Dec. 9, 1890, Evansville, Wis.
Elser, R. C., B. S. C. E., died May 17, 1900.
Emerson, Fred M., B. S. C. E., '00, 299 2nd Ave., Milwaukee, Wis., Milwaukee Bridge Co.
*Erbach, Wm. Z., B. S. M. E., '93, Athens, Wis., Lumber Business.
Erickson, Erick T., B. S. C. E., '88; C. E.,'90, 223 N. 8th St., St. Joseph, Mo.
*Evans, Ed. M., B. S. E. E., '94, 2277 Paulina St., Chicago, Ill., Bridge Inspector.
*Evans, Geo. B., B. S. C. E., '94, 348 Atlantic Ave., Pittsburg, Pa.
Fairchild, David L., B. S. C. E., '90, 17 Columbia Block, Duluth, Minn.
Falconer, Robt. C., B. S. C. E.. '95, Vanceburg, Ky.

Farris, Jas. A., B. S. M. E., '00, Harvey, Ill., Whiting Foundry Equipment Co.
Fehr, H., B. S. M. E., '84; LL. B., '86, Empire Bldg., Milwaukee, Wis., Lawyer.
Fisher, John J., B. S. C. E., '76, Prescott, Ariz., U. S. Dep't, Mineral Survey.
*Fisher, John R., B. S. C. E., '74; C. E., '80, Beaver Dam, Wis. Lumber Dealer.
Foote, F. I., Cincinnati, Ohio, Bullock Mfg. Co.
Ford, Arthur H., B. S. E. E., '95, Atlanta, Ga., Prof. Elect. Eng., Georgia Schoool of Tech.
Ford, Fred H., B. S. E. E., '93, Milwaukee, Wis., Northern Electric Co.
Fowle, Fred F., B. S. C. E., '93., Wauwatosa, Wis.
*Fowle, Harry H., B. S. E. E. '95.
Fowler, Myron M., B. S. E. E., '01, 841 W. Adams St., Chicago, Ill., Western Elec. Co., Engr. Dep't.
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Fricke, August C., B. S. M. E., '01., Corliss, Milwaukee, Wis.
Friend, J. H., B. S. E. E., '03, Chicago, Ill., Sullivan Machinery Co.
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Fugina, A. R., B. S. C. E., '98, No. 1—W. Kinzie St., Chicago, Ill., Asst. Engr. C. & N. W. Ry.
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Funk, Wm. F., B. S. M. E.,'91, 1407 Main St., La Crosse, Wis., M. Funk Boiler Works.
Gapen, J. C., B. S. E. E,, '03, Chicago, Ill., Chicago Edison Co.
Gardner, Stephen, B. S. E. E., '02, Chicago, Ill., Chicago Edison Co.
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*Grey, John C., B. S. M. E., '02.
Griffith, John H., B. S. C. E., '93, Pittsburg, Pa., J. R. Stewart Co.
Grover, A. J., B. S. C. E., '81; C. E., '83, Smithport, Pa., Res. Engr. P. S. & N. R. R.
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Minch, Oscar J., B. S. M. E,, '93, Odessa, Wash., Mgr. Odessa Milling Co.
Minch, Walter B., B. S. M. E., '00, Chicago, Ill., Western Elec. Co.
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Nicholas, A. A., B. S. E. E., '01, Chicago, Ill., Draftsman, Chicago Edison Co.
Nommenson, R. A., B. S. C. E., '99, died July 12, 1902.
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Older, Clifford, B. S. C. E., '00, Slayton, Mo., Div. Engineer C. & A. Ry.
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Olson, L. W., B. S. E. E., '99, Mansfield, O., Olin Brass Co.
Olson, M. C., B. S. E. E., '99, Schenectady, N. Y., General Elec. Co.
Olson, Sidney, B. S. C. E,, '02, died, 1902.
O'Neill, Wm. R., B. S. M. E., '87, R. F. D., No. 1, Boise, Idaho, foreman Barber Asphalt Co. Plant.
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Palmer, R. B., B. S. E. E., '01, 22 A, College Hill, Cannon St., London, Eng., care J. G. White Co., Limited.

Parmon, A. L., B. S. C. E., '85; C. E., '89, died Oct. 3, 1899, at Spokane, Wash.

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