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THE POLLUTION OF THE SCHUYLKILL RIVER by coal wastes is to be investigated by Charles E. Morgan, acting as referee. This is the result of a suit brought by the city of Philadelphia against the Philadelphia & Reading Coal & Iron Co. and others, for an injunction to restrain the latter from polluting the river by coal dust and other refuse.

A STRONG STAND FOR IMPROVEMENTS in the Philadelphia water supply was taken by the new mayor, Mr. Samuel H. Ashbridge, in his first message to councils. He recommends that measures be taken to stop waste; that the most urgent of the repairs and improvements to the works be made at once, and that he be given authority for the appointment of experts to advise regarding filtration and the general improvement of the water supply. He suggests three experts to act with the Director of Public Works and the Chiefs of the Bureaus of Water and Surveys. An appropriation of $25,000 is recommended for this investigation. Four ordinances were introduced in the Select Council on April 6 to carry out the above recommendations. The one relating to the restriction of waste increases the rate on positive or siphon flush urinals and water closets from $1 to $5 and authorizes measures to prevent the continuance of all such waste as is discovered. The mayor states that there are in the city over 100,000 old style hopper closets, in many of which water is running to waste continuously. The ordinance for improvements appropriates $250,000 for four 5,000,000-gallon pumping engines, a new pump house, a 36-in. force main and other things.

THE TYPHOID RECORDS AT PHILADELPHIA last week showed a decided falling off in cases, but an increase in deaths. The figures were 296 new cases and 48 deaths. The number of deaths was only one less than the maximum for a single week this year, but the cases were only little over half the maximum number reported for one week, which was 563 for the week ending March 25. The high mortality last week was doubtless the result of this maximum number of cases. Up to April 8, the total number of cases this year was 5,160, and of deaths 533. For the first 3 months in 1899 the deaths from typhoid fever in Philadelphia exceeded those for any whole year from 1892 to date, excepting last year. The large number of deaths among returning soldiers, some 150, brought the total up to 639. In 1891 the mortality was also heavy, there having been 683 deaths.

SUITS TO PREVENT THE DISCHARGE OF SEWAGE into the Genesee River at Rochester, through the east side trunk sewer, have been pending in the courts since 1897. A few days ago the trial of one of the suits was begun. The plaintiffs claim a nuisance and wish it stopped. There is talk of damages.

THE POLLUTION OF SARATOGA LAKE must be stopped. On March 30 Governor Roosevelt signed an order issued as a result of the recent investigation into the matter ordering the pollution from the various sources to be discontinued at the following dates: The discharge of sewage and garbage from cottages and hotels on the lake shores by or before July 1, 1899; discharge of sewage from Ballston Spa and from Saratoga Springs, and the discharge of manufacturing waste from tanneries and paper mills on the Cayaderosseros Creek, on or before April 1, 1900; provided that after that date the effluent from properly constructed disposal works, meeting the approval of the State Board of Health, may be discharged into the lake and creek mentioned. Action is already commenced to provide the disposal works and on a preliminary report by Prof. O. H. Landreth, of Schenectady, Saratoga Springs is asking authority to bond the village for $75,000, for the separation of the sewage from storm-water and the construction of the first portion of the filtration works.

ASPHALT STREETS IN BRESLAU, GERMANY, are cared for as follows, says U. S. Consul C. W. Erdman: One man has charge of four blocks, and he is equipped with an iron hopper barrow, a shovel, a broom and a rubber scraper, about 3½ ft. wide. Early in the morning, after having cleaned his section, he loads his barrow with fine sharp sand and scatters it over the street to prevent slipping; on a rainy day he repeats this several times. Once a week, two sprinkling carts, side by side, wash the street thoroughly; and these are immediately followed by four one-horse sweepers, with a brush 2 ft. diameter. These sweep the water, slime, etc., into the gutter, where it is piled up and then carted away. The keeper for that section then sands the streets. This keeper is paid 22 pfennigs, or 5 cts per hour; while ordinary street hands are paid 4 cts. per hour. The city attaches wire baskets to the lamp-posts, on fences, etc., and in these the public is required to throw all waste paper, etc. The householder is also required to sweep in front of his place and to the middle of the street regularly every morning before 6 o'clock. This refuse is carted away by city teams.

THE ELECTRIC RAILWAYS OF BRESLAU, under a 24-year charter granted by the city, permitting the existing companies to substitute electric for horse-power within two years, will use both the overhead and underground systems. The company agrees to take from the city the electric motive and lighting power required for the cars; and the city binds itself to furnish this power, but is not liable for damages in case of a breakdown at the power house. The fare is fixed at 10 pfennigs (2.38 cts.), with transfers over any part of the system. For the privilege and use of the streets the city will receive 33⅓% of the net receipts, or after deducting expenses for power, employees and repairs on track, cars and wire. After Dec. 31, 1907, the city and the company will share equally in the net profits; and at the end of the 24 years the city has the right to take charge of the property of the company. For the year ending Dec. 31, 1898, the receipts of the horse railways of Breslau amounted to $367,560. The present tram lines are 31 miles long, and employ 510 horses, each of which does an average day's work of 14 miles in single, and 15.84 miles in double harness. There are 90 closed and 40 open cars in use, and in the last year 14,470,811 persons were carried. The pay to 472 employees amounted to $114,440; the net profit was $60,493, and a 12½% dividend was paid.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Portland & Rochester R. R., at Westbrook, Me., on April 5, and was caused by a cylinder head blowing out of a passenger locomotive. The fireman was instantly killed and the engineer probably fatally injured.

A LARGE TRAVELING DERRICK fell, on April 11, at the Willis Ave. bridge, over the Harlem River, in New York, and four men were killed and seven were injured. The derrick was about 40 ft. high, ran on three tracks, and was built of 12×14-in. timbers. It ran out on a temporary trestlework, and the sinking of some piles at the end of this trestle depressed the track and caused the derrick to run off the end of the structure. The contractor for the whole structure was John C. Rogers, who sub-let the ironwork to the Edge Moor Bridge Co., of Wilmington, Del. The river bottom at this point was very treacherous, and the piles were driven to an unusual depth.

FIRE DESTROYED THE COSTLY CITY RESIDENCE of Mr. Wallace C. Andrews, President of the New York Steam Heating Co., of New York city, early on the morning of April 7, killing 12 of the 14 persons which were in the house at the time. The dead include Mr. Andrews and nearly his whole immediate family. So far, no sufficient explanation of the origin of the fire has appeared, but the indications are that the flames had been raging for some time before they were discovered, and had possibly existed for a still longer time in the cellular structure of the floors and partitions. As the house was practically burnt out clean inside, however, any explanation of this kind is entirely guesswork, and about the only significant fact that can be drawn from the fire is that our modern city residences, even of the highest and most costly class, are so inflammable and poorly protected against fire that they may easily burn down so quickly as to destroy the inmates before they can escape.

LOST CAR AND AUTOMATIC COUPLER STORIES come from the West. The "Indianapolis Journal" says that on March 17 a freight train was running at a good speed, between Anoka and Walton, on the Richmond Division of the Panhandle railway, when a car, about midway in the train, was derailed by a broken truck. The accident disconnected, but did not break, the automatic couplers, according to the story, and the car simply jumped clear of the track and free from the rear cars in the train. These rear cars caught up with the first section on the grade and automatically coupled with it, and the lost car was not missed until the run was completed. Another accident of the same kind is said to have occurred on the Chicago & Alton R. R. on Feb. 18. A train of 28 box cars, it is stated, left Bloomington, Ill., for Roodhouse, and in the center of the train was a box-car loaded with coal. When Roodhouse was reached this coal car was missing, though the train was all complete. An investigation located the missing car 40 miles from Roodhouse. It had jumped the track, with a train speed of about 40 miles per hour, and had cleared the rails by 10 ft. without turning over. The rear end of the train automatically coupled with the front section and the train continued cheerfully on its way. The "Journal" remarks very happily that "these accidents are considered unique in character."

A COLLAR FOR WORN CAR-JOURNALS is being put upon the market by the Pacific Car Equipment Co., of 206 Kearny St., San Francisco, Cal. The old journal is simply turned down sufficiently to permit a case-hardened steel sleeve to be hydraulically pressed over it. This sleeve is ¼-in. thick, and so treated that while it is case-hardened on the exterior, it is soft on the interior surface and makes a firm union with the iron. The collar is made in two forms; one is the regular collar journal, and the other is the so-called "muley" type, with a fillet at one end only. It has been tried with success by the Pullman Palace Car Co. and the Southern Pacific R. R. Co.; and the statement is made that after a 30,000-mile run the calipers could detect no wear.

THE SUDANESE RAILWAY EXTENSION, proposed by Gen. Lord Kitchener, contemplates the building of nearly 600 miles of railway. From Khartum, one line would extend 110 miles up the Blue Nile to Abu Harras, and then run southeast another 110 miles to Kedaref, and northeast about 350 miles, through Kassala, to the Red Sea, at Suakin. About 1,000 miles of telegraph will also be required to carry out the present plans. The wire would parallel the projected railway from Khartum to Abu Harras, Kedaref and Kassala, on the east of the Blue Nile; on the western side of this river the telegraph would go from Abu Harras to Sennaar, to Abba Island, and south along the Nile to Fashoda and the town of Sobat.

SHANGHAI, CHINA, invites proposals for telephone and electric railway systems. U. S. Consul General Goodnow warns bidders that they must deal with the Anglo-American settlement, the French settlement and the Chinese authorities for any franchise covering all Shanghai and the immediate suburbs, according to the cession of 1845. These settlements form a city covering less than 3 sq. miles and containing 5,650 foreigners and 410,000 Chinese. There is a telephone company there now operating 338 telephones at an annual rental of 60 to 70 taels (a tael is about 65 cts. gold); but the instruments are old and the service bad. The time set for receiving proposals, March 31, has expired, but no satisfactory bids seem to have been received. The telephone franchise was to be exclusive for 30 years, with the privilege of purchase after 15 years, with a deposit of 10,000 taels. But Mr. Goodnow remarks that a sharp competitor to the telephone exists in the person of the coolie messenger, who can be hired for $2.37 gold per month; these coolies now carry about nine-tenths of the messages. The tramway problem is complex. The franchise may be 30, 40 or 50 years, but the tender must be ratified by the rate payers after acceptance by the council of the settlements. About 23 miles would be laid at once, and the fares are fixed at 5 cts., Mexican; the overhead trolley is wanted and a deposit of £10,000 is required. At present two-wheeled jinrikishas furnish ordinary conveyance and 7,000 of them are in use, with a fare of 15 cts., Mexican, per hour. Mr. Goodnow concludes by saying that the conditions are so novel that only an expert, after carefully studying the actual ground, can make any intelligent bid.

THE SURVEY FOR THE HANKOW-CANTON Railway has been completed, and the American engineering party arrived at Shanghai on March 1, 1899. They report no trouble in doing their work; with every kindness shown them by Chinese officials and local gentry. This information comes from U. S. Consul-General Goodnow, of Shanghai.

THE FAMOUS KINZUA VIADUCT, over Kinzua Creek, 14 miles south of Bradford, Pa., is to be replaced by a larger and stronger structure to meet modern traffic demands. This viaduct is 2,052 ft. long, 302 ft. above the water at its highest point, and the highest pier is 279 ft., from top of foundation to top of pier. When built, in 1882, it was one of the highest viaducts in the world.

A FALL OF ROCK IN THE NIAGARA GORGE.

Many of our readers doubtless noticed in the newspapers, accounts of the recent fall of rock in the Niagara gorge at the Whirlpool Rapids. We show herewith a view of the gorge after the rock mass had slid down, taken from a point a short distance below the new railway steel arch bridge on the American side. The fall occurred at about 5 a. m. on March 31, and was the greatest avalanche that has occurred in the Niagara gorge for many years. The rock fell at a point just south of the Buttery elevator, just where a short time ago the wind carried away the old elevator shaft, causing it to fall upon the buildings at the foot of the new

VIEW OF NIAGARA GORGE AT THE WHIRLPOOL RAPIDS, SHOWING ROCK SLIDE OF MARCH 31, 1899.

elevator, wrecking them so that they had to be rebuilt. The mass of rock which fell in the avalanche again demolished this building, while it also carried away about 40 ft. of the lower part of the elevator shaft.

The greater part of the rock that fell came from the extreme top of the cliff, and one huge mass of limestone plunged full upon the double track of the Gorge railway, smashing the roadbed and crowding it out toward the rapids.

An examination of the point from which the avalanche came showed that another mass of rock was nearly ready to fall, and by order of Mayor Hastings this was also blasted away, and materially added to the mass on the railway tracks below. It is this view that is presented in the illustration.

Had the avalanche fallen later in the day it would very likely have caused loss of life, for since the electric road along the water's edge has not been operated, the Buttery elevator has been the most promising point from which to view the whirlpool rapids, and the number of daily visitors is always quite large.

THE NEW IRON FOUNDRY AT THE WORKS OF THE GENERAL ELECTRIC CO., SCHENECTADY, N. Y.

(With two-page plate.)

About a year ago the General Electric Co., under pressure of its increasing business, determined to erect a new foundry at its Schenectady works. The leading foundries of the country were studied, and plans and specifications were prepared embodying the latest and most approved ideas of foundry practice. These specifications were sent out to bidders on March 3, 1898, the contracts were let on March 25, and on Jan. 5, 1899, the first cast was made in the new building.

The view shown in Fig. 1 represents the condition of affairs on July 5, 1898, while Fig. 2 is an interior view taken on Dec. 31.

The new foundry is located just north of the older portion of the works, and upon ground so low that it was sometimes overflowed by floods in the Mohawk River, which flows alongside. To avoid these inundations, the entire area was filled in and brought to the same level as the older parts of the works. Before the filling was done, however, the concrete pedestal foundations, to support the building and machinery, were built, as shown in Fig. 1, and masonry curtain walls were built between the piers to form the outer wall of the building. The entire space thus enclosed was filled in to the present level. Fig. 2 is an interior view taken about five months after completing the foundations, and gives a fair idea of the framing of the finished building.

The floor plan, showing the location of the different departments, is given in Fig. 3. Steel and fireproof materials are used throughout in the construction, where there is any possibility of fire The roof is high, and as a large portion of it is made of wire glass, the interior is quite the opposite of the usual dark and dingy foundry. At present the framing is painted a cream white, which also increases the light and airy appearance. Up and down the main aisle runs one 40-ton and one 10-ton Morgan electric bridge crane with a 65-foot span, operated from the usual hanging platform. At the sides and spanning the side aisle are one 7-ton and three 5-ton electric box cranes with a span of 32 ft. The switches controlling these are operated from the floor by means of cords. There are also three portable 5-ton jib cranes, with a swing of 21 ft., which can be shifted from column to column of the main building, according to the needs of the work. There is also a 10-ton, 47-ft. span Morgan electric crane in the wing, known as the cleaning room.

The main building is 140 × 503 ft., with a wing 120 × 103 ft. There are also two lean-tos, one of 38½ × 243 ft., and the other of 11⅓ × 152½ ft. The side walls are 23¾ ft. high, the main gables 58¼ ft., the wing gables 51⅜ ft., and the walls of the cupola room 28⅜ ft. high. The cubical contents of the building is about 3,250,000 ft.

In constructing the foundations 1,833 cu. yds. of concrete were used, and 1,203 cu. yds. of stone were placed in the curtain walls. Inside the bin thus formed was placed 27,000 cu. yds. of earth filling, while outside 53,000 cu. yds. of earth were dumped to form a proper approach and continue the yard level. In the side walls and elsewhere, 1,250,000 bricks were used, and the framing for walls, roofs, etc., required 1,200 tons of steel.

The roof contains 23,336 sq. ft. of wire glass, while the side windows and monitor windows have an area of 12,336 sq. ft. The monitor windows on each side are all so connected that by simply pulling a chain the 83 windows on each side can be moved as much as desired. This, together with the heating system, which blows fresh air into the building, enables the entire volume of contained air to be rapidly changed when castings are being shaken out.

Outside, as will be seen in the plan, Fig. 3, are several sheds for the storage of different sands with a total capacity of 6,000 tons; similar sheds, with a capacity of 600 tons, are also provided for coke storage. There are also other sheds for the storage of clay, fire sand, patterns and small ladles, and a storage yard for scrap and pig iron. These are all convenient to the main railway tracks, and Hunt Industrial Railway tracks run in between the sheds and connect with the tracks inside the main building, so that materials can be brought in or removed with a minimum amount of labor.

Coming from the direction of the main office, a visitor enters the wing building or cleaning room, which is devoted exclusively to the final or finishing cleaning of the products of the foundry. Near the main door, in line with and forming part of the central track, is a 10-ton Fairbanks scale. To the left are 7 tumblers and two roughing emery wheels operated by a 5-HP. motor. These tumblers connect with a special draft, or up-take chimney, which removes all dust. On the right-hand side of the room are the pickling tanks, while overhead is the 10-ton electric crane already mentioned.

Passing into the main room, which consists of a central and two side aisles, the sand-mixing bins, large and small core ovens, core-making benches and cupolas are noticed on the right side, while the heating and ventilating equipment, lavatory, pattern-room, and flask-making room are on the left. The central aisle is free of all obstructions to allow the cranes to have full sweep of the molding floor. The floor of this portion contains a series of lined pits, into which molding sand has been packed to a depth of about 8 ft. These are used for large castings, and for sweeping out floor molds for cores, a process which saves to a considerable extent the making of large patterns.

Sand mixing is accomplished by means of a Sellers' centrifugal mixer operated by a 3-HP. motor, the whole being mounted on a truck, so that it can be moved about. Two large and four small core ovens are provided. Each large oven has three parallel tracks and a separate furnace. The doors of these ovens, Fig. 5, are made in four sections, and are hinged at the sides with special ball-bearing hinges which make them remarkably easy to open and close. Their construction is so fully shown in the figures that no further explanation is necessary. The four small ovens are really only one long oven, with four automatic racks, which are shoved out or drawn back at the will of the operator, by pneumatic cylinders attached to the bottom of the car. The construction of these cars and the operating machinery are shown in Fig. 6. The air supply to operate these is admitted at the back end of the piston rod, and is obtained from a small automatic compressing plant, similar to those placed on electric cars. This consists of a compact air-compressor direct-connected to a small electric motor. Attached to the air reservoir and the conductors supplying current for operating the motor is an automatic switch so designed that when the air pressure in the reservoir drops below a certain amount the current is switched onto the motor, which starts up and brings the pressure up to the proper value. When this is reached the switch again comes into play and cuts off the current.

Near these ovens are the core-making benches, and the storage and drying racks, so that the handling of this material is minimized.

The cupola room comes next, and this will eventually contain 3 Colliau cupolas capable of melting 18, 11 and 7 tons per hour, respectively, although at present only the 18 and 7-ton cupolas are installed. The cupola charging floor is made of steel plates, riveted to the floor beams, which are designed to carry sufficient material for a considerable run. To carry the coke and iron to the charging floor a 2,200-lb. hydraulic elevator is provided. Air for the blast is furnished by a Root blower with a capacity of 660,000 cu. ft. of air per hour at 95 revolutions.

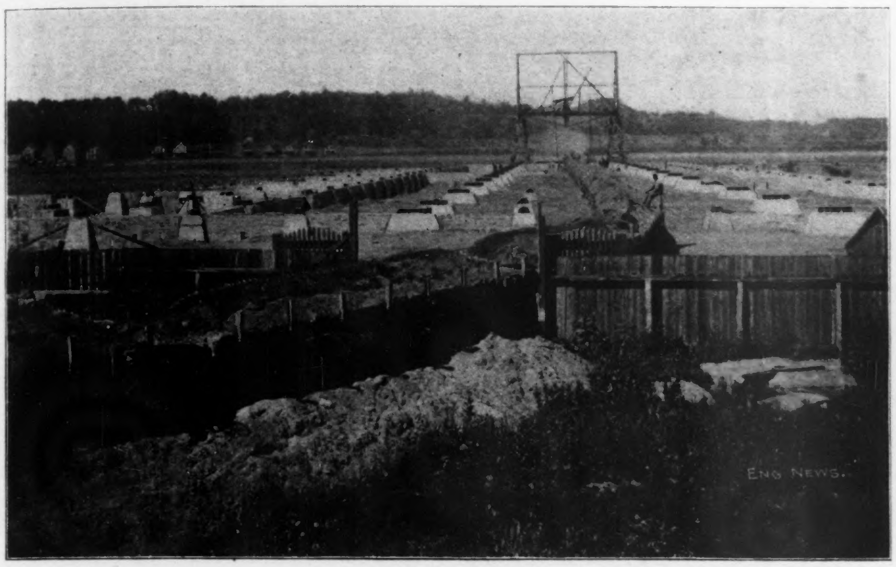


FIG. 1.—VIEW SHOWING COLUMN FOUNDATIONS AND PARTIALLY FILLED-IN FLOOR.

(Taken July 5, 1898.)

The blower is driven by a 60-HP. motor. There are 7 ladles provided for the cupolas of 15, 10, 6, 4, 3½, 2 and 1½ tons capacity.

On the other side of the main building, starting from the end and coming back, the first room is one of the two devoted to heating and ventilating. It contains a Buffalo Forge Co.'s heating blast fan 14 ft. in diameter and 6 ft. wide, which is driven by a 35-HP. motor. It draws air through steam coils having 27,500 sq. ft. of heating surface, and forces it out through a long sheet steel main pipe. Smaller pipes branch from this with nozzle-shaped apertures which discharge the air overhead with sufficient velocity to effect satisfactory distribution.

The next room is devoted to flask-making, and the machinery in it is driven by a 7-HP. motor. Further on is the pattern storage room, where such patterns as are in frequent use are stored. The superintendent's office occupies a portion of this room, and project out into the main room like a bay window. As the office is raised above the main floor level, an uninterrupted view of the entire foundry can be obtained from its glass windows. Adjoining the pattern room are the water-closet and lavatory in separate rooms. The lavatory or wash-room is a large and well-lighted room, provided with four lines of double wash bowls and 300 lockers built of heavy iron wire lattice. These are assigned to the men upon the deposit of a sum sufficient to cover the cost of the key and minor repairs to lockers. There are also four shower baths, with a dressing-room attached, which are free for the use of all.

Just beyond is the other heating and ventilating room, with a 14 × 7-ft. Buffalo Forge Co.'s blast fan driven by a 35-HP. motor, and, like the other one, drawing air over steam coils with a heating surface of 27,000 sq. ft.

A very complete system of tracks for moving material is provided, as shown in Fig. 3.

The steel work of the building was furnished and erected by the Hilton Bridge Construction Co., of Albany, N. Y. We are indebted to the courtesy of the General Electric Co. for the opportunity of visiting and inspecting the foundry, and for the prints from which our illustrations of it are prepared.

SOME OBSERVATIONS ON THE USE OF POLAR PLANIMETERS.

By Walter W. Patch.*

Although the polar planimeter is often used by engineers to facilitate the computation of earth and rock excavation, yet there are few published data as to the degree of accuracy of results obtained by its use under ordinary working conditions; and as these instruments are liable to be somewhat out of adjustment, it is thought that the following notes, collected during several years' experience in this class of work, might be of interest.

One of the commonest applications of the planimeter is in finding the area of vertical sections in earthwork, preliminary to calculating the contents by the "end area" method. Such vertical sections, or end areas, are usually plotted on continuous profile paper, or on cross-section sheets ruled in squares. As the shape of any section is largely influenced by the relative horizontal and vertical scales adopted, and as the accuracy of planimeter work can be shown to depend in a measure on the shape of the sections, it is important that care be exercised in the selection of scales for plotting. The field work on profile lines is ordinarily taken to the nearest foot in distance, and to tenths of a foot in elevation. Hence the scales of the plot, to be consistent, ought to indcate those space intervals with certainty. In the case of the standard continuous profile papers "A" and "B," when the field work is within the limits just stated, the horizontal scale should not be more than 40 ft. to the inch, and 0.1-ft. on the vertical scale not less than one-half the distance between the fine horizontal lines. Within these limits the scales should be proportioned so as to keep "area of section" divided by the "perimeter of section" at a maximum.

This ratio, hereafter called R, determines more than any other one thing, aside from the planimeter itself, the degree of precision to be attained in any case. Before proceeding, however, to discuss the effect due to different values of R, it is well to examine some of the other factors having a bearing on the accuracy of the work. These are three: (1) Errors in printed scale of profile paper. (2) Variation in personal equation of planimeter observer. (3) Errors due to non-adjustment of planimeter.

The first source of error is so well known as to require no further comment. The second is an individual characteristic, varying for different observers, and depending on the direction and intensity of the light as it reaches the tracer point of the planimeter, and also on the physical condition of the observer; for as the eye and brain become wearied by long-continued effort, the closeness with which the tracer point follows the outline of the sections is apt to be diminished.

The third source of error, that due to the instrument, is not generally appreciated at its full value; yet it is often of more importance than all the other errors combined. It is caused by a lack of parallelism existing between the axis of the contact wheel and the line joining the tracer point with the pivot at the intersection of the tracer and anchor arms. This adjustment is tested by traversing a certain area (commonly a circle of

*Assistant Engineer Metropolitan Water Board, 3 Mt. Vernon St., Boston, Mass.

FIG. 2.—INTERIOR OF NEW IRON FOUNDRY, GENERAL ELECTRIC CO., SCHENECTADY, N. Y.
(Taken Dec. 31, 1898.)

TABLE I.—Showing the Percentage by Which the Record for a Given Area Differs for the extreme values of δ.

No. of planimeter.	Variation in record for extreme values of angle δ.	No. of planimeter.	Variation in record for extreme values of angle δ
413	1.8%	7	0.9%
412	0.4%	8	2.8%
408	1.3%	11	0.8%
425	0.2%	51	0.0%

Remarks.—The position giving the maximum acute value to δ showed the greater record in each case, except the last.

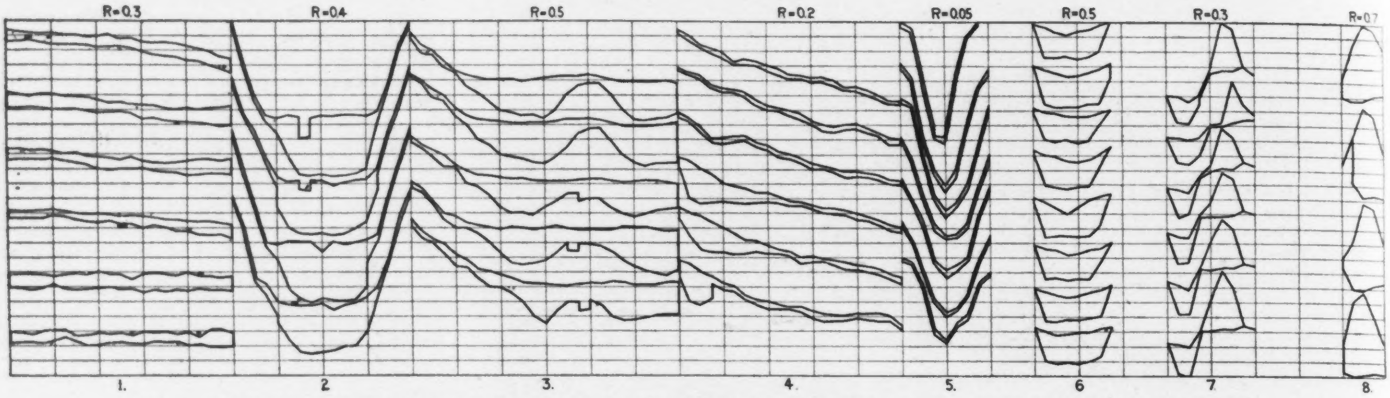


FIG. 1.—TYPICAL CROSS-SECTIONS PLOTTED ON "PLATE B" PROFILE PAPER FOR PLANIMETER CALCULATIONS.

fixed radius) with the angle, hereafter called δ, between the axis of the contact wheel and a line joining the anchor with the point where the contact wheel touches the paper constantly acute, and then traversing the same area with the angle δ constantly obtuse. If the area registered in the first instance, i. e., when the angle δ is acute, is greater than that recorded when this angle is

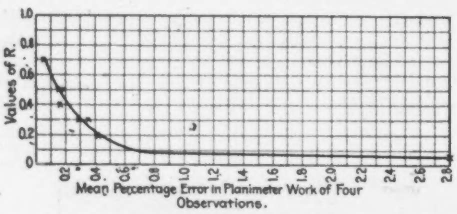


Fig. 2.—Diagram Illustrating the Relation Between Different Values of R, and the Percentage Error in Planimeter Work.
Plotted from Results of Observations with Planimeter No. 7.

obtuse, then the adjustment is to be made by shifting the tracer point, by means of its adjusting screws, away from the anchor arm, or to the left when facing the instrument, with the tracer point nearest the observer. If the relation between the recorded areas is reversed, the tracer point is moved in the opposite direction. In cases where sufficient latitude has not been allowed in the tracer point adjustment, it is sometimes possible to complete the adjustment by shifting the contact wheel carriage.

Out of eight polar planimeters recently tested, only one gave identical results for the same area when traversed under the two extreme positions before noted. Table I. shows the percentage difference in each case; and it is of interest to note that the area recorded when the angle δ was acute, was the greater in every instance except for No. 51. These instruments represented several reliable makes, and were of the best type of the ordinary polar planimeter; each having a graduated arm, and recording areas to 0.01 sq. in. when set to read square inches.

It is generally possible to adjust so that a given area will be registered the same in the extreme positions of the anchor with respect to the tracer arm, but it sometimes happens that an intermediate position will give a different result, as in the case of No. 412, which, after adjusting for the extreme positions, gave 0.6% less for the same area when the angle δ averaged about 90°.

In order to obtain the best results in the use of the planimeter, some method of working must be followed which will neutralize as far as possible these sources of error. The usual custom is to adjust the graduated arm, when starting on a sheet of sections, so as to record square inches when traversing some given rectangle whose area is known in terms of the scale of the profile paper, and to use that setting for the entire sheet. The following scheme, however, is more scientific, and is believed to give better results.

Consider a sheet containing eight series of cross-sections, as in Fig. 1. These sections are plotted on "Plate B" continuous profile paper, and are typical of reservoir stripping and borrow pit work; except that the top and bottom shots are plotted in the same vertical line, and are separated by uniform horizontal distances in order to facilitate the arithmetical calculation of the areas. They show examples of meadow, swamp, and steep side hill stripping, channels and borrow pits.

TABLE III.—Showing Results of Observations Made With Planimeter No. 7.

No. of row of sectns.	Quantity calculated arithmetically, cu. ft.	By planimeter, observer No. 1, cu. ft.	Percentage of error.	Observer No. 2, cu. ft.	Percentage of error.	Observer No.3, cu. ft.	Percentage of error.	Observer No.4, cu. ft.	Percentage of error.	Values of R.	Average per ct. error of 4 observers.
1....	146,340	146,130	— 0.14	145,320	— 0.70	145,930	— 0.28	146,290	— 0.03	0.3	0.29
2....	189,590	189,480	— 0.06	190,320	+ 0.38	189,550	— 0.02	189,210	— 0.20	0.4	0.17
3....	285,780	285,390	— 0.14	285,810	+ 0.01	286,550	+ 0.27	285,260	— 0.18	0.5	0.15
4....	98,940	99,240	+ 0.30	99,480	+ 0.55	99,050	+ 0.11	99,650	+ 0.72	0.2	0.42
5....	26,590	26,630	+ 0.15	27,500	+ 3.42	27,520	+ 3.50	27,690	+ 4.14	0.05	2.80
6....	141,090	140,560	— 0.38	140,790	— 0.21	141,000	— 0.06	141,000	— 0.06	0.5	0.18
7....	97,660	97,580	— 0.08	96,920	— 0.76	97,210	— 0.46	97,540	— 0.12	0.3	0.35
8....	106,410	106,310	— 0.09	106,380	— 0.03	106,420	+ 0.01	106,320	— 0.08	0.7	0.05
Tot'l.	1,092,400	1,091,320	— 0.10	1,092,520	+ 0.01	1,094,100	+ 0.16	1,092,960	+ 0.05	...	0.08

To determine their areas, the graduated arm of the planimeter may have any setting, but as a matter of convenience is usually set at the mark supposed to be correct for recording square inches. Then for each series a trial rectangle of 10 sq. ins. is marked off on the profile sheet. For series 1 this rectangle would measure 10 ins. × 1 in., located near the bottom of the row, with the long dimension horizontal. For series 2 the trial rectangle would be 5 ins. × 2 ins. near the middle of the row. For series 3, 10 ins. × 1 in. near the top of the paper; and so on, spacing these areas symmetrically on the profile sheet, and having them long and narrow, or short and wide, to correspond in a general way with the shape of the sections. Then starting with series 1, the planimeter is so placed as to traverse conveniently one of the cross-sections, and the mean value of the angle δ noted. The record for the trial area is now obtained by taking a mean of five results, keeping the average value of δ approximately the same as will be used in the case of the cross-sections. The difference between the recorded area and the 10 sq. ins. indicated by the scale of the profile paper, is to be applied as a percentage correction to the sum of the areas recorded for the series. The advantages claimed for this method are:

(1) The symmetrical placing of the trial areas, together with their frequency, tends to offset errors in the scale of the paper.

(2) Having a number of trial areas to be traversed as the work progresses, provides for any change in the personal equation.

(3) By keeping the same mean value of the angle δ in both trial area and cross-sections, the effects of non-adjustment of the planimeter are largely eliminated.

It might be suggested that by placing the instrument so as to keep the mean value of δ about 90°, that the errors due to non-adjustment would balance. But in practice the shape of the sections would often render such a position very inconvenient.

Following the scheme outlined above, the quantities represented by the cross-sections in Fig. 1 have been calculated by three different observers, using planimeter No. 413, and by four observers using planimeter No. 7, with the results shown in Tables II. and III. The planimeters were used before being adjusted, and were in the condition shown in Table I. No. 7 represents, perhaps, the average condition of polar planimeters, and No. 413 is not an extreme case.

In all the work here shown the practice has been to traverse each area three times, recording the reading each time; then if the difference between extreme records was more than 0.06 on the graduated vernier scale, additional readings were made until the difference between extreme records divided by their number was not more than 0.02. This was found to be a good working limit, greater precision not being practicable where much work is to be done. In calculating quantities the mean of the several records for each area was always used, excepting that occasional observations might be thrown out for obvious mistakes. As before noted, the area used for obtaining the correction was determined from a mean of five observations.

TABLE II.—Showing Results of Observations Made With Planimeter No. 413.

Row of sections.	Quantity calculated arithmetically, cu. ft.	By planimeter, Observer No. 1, cu. ft.	Percentage of error.	Observer No. 2, cu. ft.	Percentage of error.	Observer No. 3, cu. ft.	Percentage of error.	Values of R.	Average per ct. error of 3 observers.
No. 1............	146,340	146,720	+ 0.26	145,140	— 0.82	146,420	+ 0.05	0.3	0.38
" 2............	189,590	188,210	— 0.73	190,350	+ 0.40	190,420	+ 0.44	0.4	0.52
" 3............	285,780	283,110	— 0.94	284,620	— 0.41	286,190	+ 0.14	0.5	0.50
" 4............	98,940	98,610	— 0.33	99,180	+ 0.24	99,230	+ 0.29	0.2	0.29
" 5............	26,590	26,970	+ 1.43	26,920	+ 1.24	27,450	+ 3.23	0.05	1.97
" 6............	141,090	140,910	— 0.13	140,700	— 0.28	140,970	— 0.09	0.5	0.17
" 7............	97,660	97,740	+ 0.08	97,710	+ 0.05	97,850	+ 0.19	0.3	0.11
" 8............	106,410	106,250	— 0.15	105,380	— 0.97	106,040	— 0.35	0.7	0.49
Total	1,092,400	1,088,520	— 0.36	1,090,000	— 0.22	1,094,570	+ 0.20	...	0.26

TABLE IV.—Showing Comparison Between Results Obtained by Using a Rectangular Correction Area of 10 Sq. Ins., and by Using One of the Sections in Each Row for a Correction Area.

		Using Planimeter No. 413.									Using Planimeter No. 7.								
		Observer No. 1.				Observer No. 2.					Observer No. 1.				Observer No. 2.				
No. of row of sections.	Quantity calculated arithmetically, cu. ft.	By planimeter, using 10 sq.in. correct'n, cu. ft.	Per cent. of error.	By planimeter, using section correct'n, cu. ft.	Per cent. of error.	By planimeter, using 10 sq.in. correct'n, cu. ft.	Per cent. of error.	By planimeter, using section correct'n, cu. ft.	Per cent. of error.	Values of R.	By planimeter, using 10 sq.in. correct'n, cu. ft.	Per cent. of error.	By planimeter, using section correct'n, cu. ft.	Per cent. of error.	By planimeter, using 10 sq.in. correct'n, cu. ft.	Per cent. of error.	By planimeter, using section correct'n, cu. ft.	Per cent. of error.	Values of R.
1.......	146,340	146,720	+0.26	146,280	−0.04	145,140	−0.82	144,720	−1.11	0.3	146,130	−0.14	145,700	−0.43	145,320	−0.70	146,040	−0.20	0.3
2.......	189,590	188,210	−0.73	189,910	+0.17	190,350	+0.40	189,780	+0.10	0.4	189,480	−0.06	190,240	+0.34	190,320	+0.38	188,820	−0.41	0.4
3.......	285,780	283,110	−0.94	285,390	−0.14	284,620	−0.41	284,610	−0.41	0.5	285,390	−0.14	285,950	+0.06	285,810	+0.01	286,650	+0.30	0.5
4.......	98,940	98,610	−0.33	99,390	+0.45	99,180	+0.24	97,080	−1.88	0.2	99,240	+0.30	99,140	+0.20	99,480	+0.55	96,270	−2.70	0.2
5.......	26,590	26,970	+1.43	26,890	+1.13	26,920	+1.24	26,760	+0.64	0.05	26,630	+0.15	27,450	+3,23	27,500	+3.42	26,490	−0.38	0.05
6.......	141,090	140,910	−0.13	141,340	+0.18	140,700	−0.28	140,430	−0.47	0.5	140,560	−0.38	141,260	+0.12	140,790	−0.21	140,670	−0.30	0.5
7.......	97,660	97,740	+0.08	97,450	−0.22	97,710	+0.05	97,710	+0.05	0.3	97,580	−0.08	97,380	−0.29	96,920	−0.76	97,890	+0.24	0.3
8.......	106,410	106,250	−0.15	106,670	+0.24	105,380	−0.97	106,230	−0.17	0.7	106,310	−0.09	106,410	0.00	106,380	−0.03	105,540	−0.82	0.7
Total.	1,092,400	1,088,520	−0.35	1,093,320	+0.08	1,090,000	−0.22	1,087,320	−0.47	...	1,091,320	−0.10	1,093,530	+0.10	1,092,520	+0.01	1,088,370	−0.37	...

Table III. shows clearly, what might have been expected, that the instrument in better adjustment gave the closer results. This difference will be more apparent upon examining Table V., in which the mean percentage error of each observer is given for each instrument. The percentage for row No. 5 is omitted in calculating the mean, as it was so great in most cases as to obscure the effect of the others. By referring to Tables II. and III., it will be seen that the error in the total quantity is less in each case than the mean error of the observer, as given in Table V.

In order to determine whether any advantage would accrue by using for the correction area one of the cross-sections in each row, instead of the rectangle of 10 sq. ins., the selected section was traversed five times, and the percentage correction applied to the other areas in the row, as before described. Table IV. shows the comparison of results obtained by this method of correcting, and by that first mentioned, in the case of two observers using two planimeters. They indicate a loss rather than a gain in precision, except in one instance, that of observer No. 1 using planimeter No. 413. Observer No. 3 used a correction rectangle of 50 sq. ins., as well as one of 10 sq. ins., but without any increase of accuracy in favor of the larger rectangle.

TABLE V.—Showing the Effect of Adjustment of Planimeter Upon the Mean Percentage Error of Observers.

Observer.	Mean per cent. of error using planimeters— No. 413.	No. 7.
No. 1.	0.37	0.17
" 2.	0.45	0.38
" 3.	0.22	0.17
" 4.	....	0.20
Average.............	0.35	0.23

The accompanying diagram, Fig. 2, is plotted from data given in Table III.; figures in the last column of the table being used for abscissas, and those in the preceding column for ordinates. A study of this diagram, in connection with the cross-sections shown in Fig. 1, indicates very plainly the close relation existing between high values of R (area of section divided by perimeter of section), and small errors in planimeter work. It is sometimes stated in articles on the planimeter that these instruments are more accurate on large than on small areas. This is probably true when the large areas have the larger values of R, but may not be so when the reverse is the case. The truth of this statement will be more apparent upon examining Table III., in which it is found that the mean error for the cross-sections in row No. 6, where R is 0.5, is 0.18, as against 0.29 for the mean error for row No. 1, where R is 0.3, although the areas in row No. 1 are about one-third larger than those in row No. 6. Similarly for rows No. 4 and No. 7, which have nearly equal areas, the sections having the larger value of R give the smaller mean error. Where sections have the same values of R, as in rows No 3 and No. 6, the mean error is less for the larger area.

The importance of selecting proper scales for plotting is well illustrated by the following case which occurred in actual practice. Cross-sections on a number of shallow borrow pits had been plotted on paper ruled to tenths of an inch, with a horizontal scale of 20 ft. and a vertical scale of 10 ft. to an inch. In calculating the final estimate the planimeter was not used, the quantities being determined arithmetically directly from the field notes. The areas of the cross-sections, 39 in all, and representing five borrow pits, were then obtained by planimeter by a skilled observer, who followed the methods of working just described. The average value of R for these sections was less than 0.1, and the percentage errors of the quantities from the different borrow pits varied from 0.30% to 7.50%, the error in the total quantity from the five pits being 1.90%. As the result by planimeter was too large in every instance, the cross-sections were carefully tested for errors in plotting, when it was found that while lines representing the original surface were substantially correct, those for the excavated surface were often plotted from one-tenth to two-tenths of a foot too low. As a tenth of a foot was but 0.01 in. on the vertical scale adopted, and as the borrow pits were but three or four feet deep, it can be readily seen that errors in the estimation of the small subdivisions of the vertical scale, especially if they are mostly on the same side, could easily cause a considerable error in the final result.

In summarizing, it may be stated that when a quantity is represented by 20 or 30 cross-sections, whose values of R are not less than 0.3, if the planimeter is in good adjustment, and if proper precautions are taken to eliminate or to balance all known errors, the final result should rarely be in error more than 0.2%. And if the number of sections or the values of R be largely increased, the percentage error would probably be still further diminished. In concluding, the writer wishes to acknowledge his indebtedness to Messrs. L. L. Street, F. D. Low and A. B. Cutter, through whose assistance it was possible to compare the work of several observers.

RULES FOR THE NATIONAL BOARD OF FIRE UNDERWRITERS FOR THE USE OF ACETYLENE GAS.

The Committee on Lighting, Heating and Patents, of the National Board of Fire Underwriters has recently adopted a code of rules to govern the installation of acetylene gas apparatus. This code was prepared by a special committee, composed of Messrs. Chas. A. Hexamer, Philadelphia; W. A. McCutcheon, Pittsburg; W. C. Robinson, Chicago; F. M. Griswold, New York, and W. B. Medlicott and Ellwood Hendrick, Boston. We print these rules below, as they are of special interest, not only to those installing acetylene lighting apparatus but to the numerous inventors and engineers who are working on the design of apparatus for the generation of the gas. Additional copies of these rules can be obtained on application to Mr. H. K. Miller, 156 Broadway, New York. The rules are published in the last number of the Journal of the Franklin Institute, in connection with a paper by Mr. Hexamer.

The use of liquid acetylene or gas generated therefrom is absolutely prohibited. The permission to generate and use acetylene in insured premises shall be subject to the following rules:

APPARATUS.

It is desirable that all acetylene gas machines shall be installed outside of the building insured, but special permission may be granted in the discretion of tariff associations having jurisdiction to install machines inside the building under special circumstances, such permission to be given in writing and shall be subject to the following rules:

(1) Must be made of iron or steel, and in a manner and of material to insure stability and durability.

(2) Must have sufficient carbide capacity to supply the full number of burners during the maximum lighting period.

Note.—This rule removes the necessity of recharging at improper hours. Burners almost invariably consume more gas than their rated capacity, and carbide is not of staple purity, therefore there should be an assurance of a sufficient quantity to last as long as light is needed. Another important feature is that in some establishments burners are called upon for a much longer period of lighting than in others, which requires a generator of greater gas-producing capacity.

(3) Must be uniform and automatically regulated in its action, producing gas only as immediate consumption demands, and so designed that gas is generated without excessive heating at all stages of the process.

Note.—This rule is necessary, because the presence of excessive heat tends to change the chemical character of the gas and may even cause its ignition.

(4) Apparatus not requiring pressure regulators must be so arranged that the gas pressure cannot exceed 3 ins. water column.

(5) Must be provided with an escape pipe which will operate in case of the over-production of gas, and also an attachment acting as an escape or relief in case of abnormal pressure in the machine, and which will carry such excess gas through an escape pipe of at least ¾-in. internal diameter to a suitable point outside of building, discharging at least 12 ft. above ground level and provided with an approved hood.

Note.—Both the above safety vents may be connected with the same escape pipe.

(6) Apparatus requiring pressure regulator must be so arranged that the gas pressure cannot exceed 3 lbs. per sq. in. Such apparatus must be provided with additional safety blow-off attachment located between the pressure regulator and the service pipes and discharging to the outer air, the same as provided for in Rule 5.

Note.—This is intended to prevent the possibility of under pressure of gas in the service pipe by failure of pressure regulator.

(7) Must be so arranged that when being charged the back flow of gas from the holder will be automatically prevented, or so arranged that it is impossible to charge the apparatus without first closing the supply pipe to holder, or to other generating chambers, if any.

Note.—This is intended to prevent the dangerous escape of gas.

(8) Must be so arranged as to contain the minimum amount of air when first started or recharged, and no device or attachment facilitating or permitting mixture of air with the gas, prior to consumption, except at the burners, shall be allowed.

Note.—Owing to the explosive properties of acetylene mixed with air, machines should be so designed that such mixtures are impossible.

(9) No valves or pet-cocks opening into the room from gas-holding part or parts, the draining of which will allow an escape of gas, shall be permitted; and the condensation from all parts of the apparatus must be automatically removed without the use of valves or mechanical working parts.

Note.—Such valves and pet-cocks are not essential; their presence increases the possibility of leakage. The automatic removal of condensation from the apparatus is essential to the safe working of the machine.

(10) The water supply to generator must be so arranged that gas will be generated long enough in advance of the exhaustion of the supply already in the gas-holder to allow of the using of all lights without exhausting such supply.

Note.—This provides for the continuous working of the apparatus under all conditions of water feed and carbide charge, and it obviates the extinction of lights through intermittent action of the machine.

(11) No carbide chamber of over 25 lbs. capacity shall be allowed in any machine where water is introduced in small quantities or where the contact of water with carbide is intermittent.

Note.—This tends to reduce the danger of overheating, and provides for the division of the carbide charges in machines of these types of large capacity.

(12) Generator must be connected with the gas-holder in such manner that it will, at all times, give open connection either to the gas-holder or to the blow-off pipe into the outer air.

Note.—This prevents dangerous pressure within or the escape of gas from generating chamber.

(13) Must be so designed that the residuum will not clog or affect the working of the machine and can conveniently be handled and removed.

(14) Covers to generators must be provided with secure fastenings to hold them properly in place, and those relying on a water seal must be submerged in at least 12 ins. of water. Water seal chambers for covers depending on a water seal must be 1½ ins. wide and 15 ins. deep, except-

ing those depending upon the filling of the seal chambers for the generation of gas, where 9 ins. will be sufficient.

(15) Holder must be of sufficient capacity to contain all gas generated after all lights have been extinguished.

Note.—If the holder is too small and blows off frequently after lights are extinguished there is a waste of gas. This may suggest improper working of the apparatus and encourage tampering.

(16) The bell portion must be provided with a substantial guide to its upward movement, center guide preferred, and a stop acting about 1 in. above the blow-off point.

Note.—This tends to insure the proper action of the bell and decrease the liability of escaping gas.

(17) A space of at least 3 ins. must be allowed between the sides of the tank and the bell.

(18) All water seals must be so arranged that the water level may be readily seen and maintained.

(19) Gas-holders constructed upon the gasometer principle must be so arranged that when the gas bell is filled to its maximum its lip or lower edge shall at all times be submerged in at least 9 ins. of water.

(20) The supply of water to the generator for generating purposes shall not be taken from the water seal of any gas-holder constructed on the gasometer principle.

Note.—This provides for the retention of the proper level of water in the generator.

(21) The apparatus shall be capable of withstanding fire from outside causes without failing apart or allowing the escape of gas in volume.

Note.—This prevents the use of joints in the apparatus relying entirely upon solder.

(22) Gage glasses, the breakage of which would allow escape of gas, shall not be permitted.

(23) Where purifiers are installed, they must conform to the general rules for the construction of other apparatus and allow the free passage of gas.

(24) The use of mercury seals is prohibited.

Note.—Mercury has been found unreliable as a seal in acetylene apparatus.

(25) Construction must be such that liquid seals shall not become thickened by the deposit of lime or other foreign matter.

(26) Apparatus must be constructed so that accidental siphoning of the water is impossible.

(27) Flexible tubing, swing joints, packed unions, springs, chains, pulleys, stuffing boxes and lead or fusible piping must not be used on apparatus, except where the failure of the part will not vitally affect the working or the safety of the machine.

(28) There shall be plainly marked on each machine the maximum number of lights it is designed to supply and the amount of carbide necessary for a single charge.

To be approved, acetylene generators must conform to the foregoing standard, and plans and specifications in detail of such apparatus must be submitted to the insurance organization having jurisdiction over the territory in which such apparatus is to be installed, for approval by an inspector duly authorized by the .... Association, with whom a copy of such plans and specifications must be filed. If the plans are approved, a special examination of the generating apparatus will be made at the expense of the applicant, and if it is found to be in compliance with the standard, a certificate of approval will be issued.

CALCIUM CARBIDE.

(1) In no case shall calcium carbide be stored in bulk.

(2) Calcium carbide must be packed in screwed-top, water-tight metal packages, having all seams lock-jointed and soldered. They shall contain not over 125 lbs. of carbide, and each package must be conspicuously marked "Calcium Carbide, Keep Dry." The packages must be of sufficient strength to insure the handling of the same without rupture, and they must be kept under cover at all times.

WARRANTED.

(1) That the generator shall be charged, and calcium carbide handled by daylight only;

(2) That no direct fireheat or artificial light shall be allowed in the room containing the apparatus;

(3) That no calcium carbide shall be kept in the building where this policy covers;

(4) That no greater number of lights shall be installed than the maximum for which the machine is rated;

(5) That no change shall be made in the installation without the written consent of the insurance company indorsed thereon.

CAUTIONS.

Calcium carbide should be kept in water-tight metal cans, by itself, outside of any insured building, under lock and key, and where it is not exposed to the weather. A regular time should be set aside for attending to and charging the apparatus during daylight hours only.

In charging generating chambers, clean all residuum carefully from the containers and remove it at once from the building. Separate the unexhausted carbide, if any, from the mass and return it to the container, adding new carbide as required. Be careful never to fill container over half full, as it is important to allow for the swelling of carbide when it comes in contact with the water. Never place carbide into the containers until all residuum has been carefully removed.

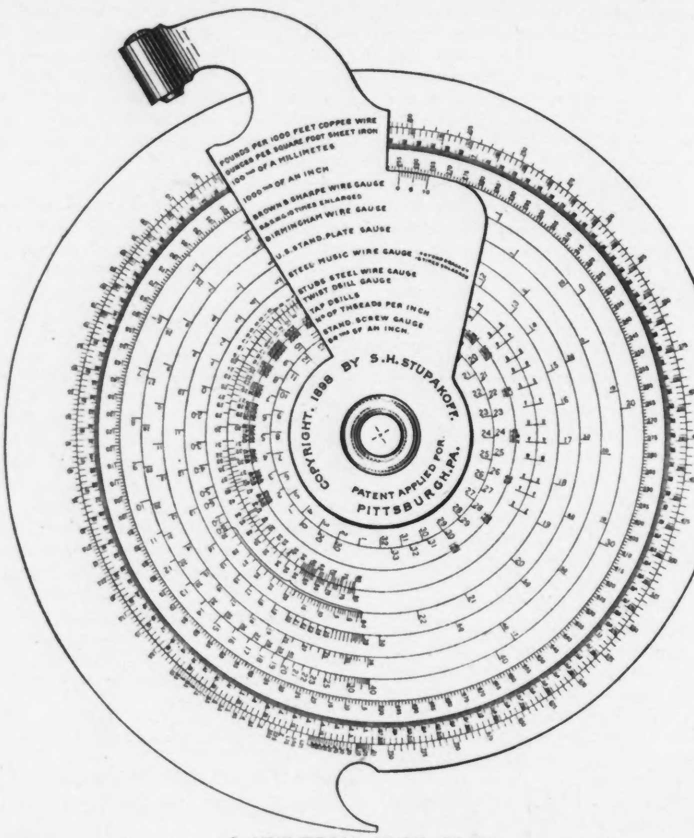
Water tanks and water seals must always be kept filled with clean water.

Where apparatus is not intended for use throughout the year, all water must be removed at the end of season. Never use a lighted match, lamp, candle or any open light near the machine.

WIRE GAGES AND THE STUPAKOFF COMPAROMETER.

From a valuable paper on wire gages, read before the German-American Engineers' Society, of Pittsburg, Pa., by Mr. S. H. Stupakoff, M. E., we make the following abstract:

Wire gages indicate certain series of dimensions and determine the thickness of metal sheets and the diameters of wires by numbers. This gage number is, without exception, a certain invariable dimension; and a series of such dimensions is called a standard gage, and is usually designated by the name of its maker, or it describes the purpose for which it was intended.



A UNIVERSAL WIRE GAGE.

No system was recognized in the progression of sizes for gage numbers until Brown & Sharpe, of Providence, R. I., established the "B. & S.," or American Standard Wire Gage, adopted and recommended by the Franklin Institute. While this gage rightly stands first, at least ten other gages are used in this country, as follows: (1) Brown & Sharpe; (2) Birmingham Wire Gage; (3) U. S. Standard Gage for Plates; (4) Stub's Steel Wire Gage; (5) Morse Twist Drill Gage; (6) Steel Music Wire Gage; (7) American Standard Screw Gage; (8) Roebling's Wire Gage; (9) Washburn & Moen's Wire Gage; (10) Trenton Iron Co.'s Wire Gage; (11) Edison Wire Gage. The first seven in this list are in almost daily use in most of our larger manufacturing establishments.

England differs in her practice, and the following list gives some of the principal gages employed in that country: (1) British Legal Standard Gage; (2) Birmingham Wire Gage; (3) Birmingham Sheet Metal Gage; (4) Whitworth Wire Gage; (5) Warrington Wire Gage; (6) Lancashire Gage for Round and Pinion Wire; (7) Sheet and Hoop Iron Gage; (8) English Zinc Gage; (9) Birmingham Gage for Silver and Gold. The French Decimal, or Limoges gage, is extensively used in several countries, though not to the exclusion of others.

The U. S. Standard gage for sheet metal, plate iron and steel was established by Act of Congress and went into force on July 1, 1893; it was subsequently adopted as a standard by the American Railway Master Mechanics' Association, and the Association of American Steel Manufacturers. This gage, for plates, has for its base the weight of sheet-iron per sq. ft.; or, with one cubic foot of iron weighing 480 lbs., one square foot ½-in. thick will weigh 20 lbs.; this represents the largest number on the gage, or 7-0. The smaller numbers decrease in weight 20 ozs. each from No. 7 to No. 1; 10 ozs. each from No. 1 to No. 14; 5 ozs. each for Nos. 15 and 16; 4 ozs. each for Nos. 17 to 20; 2 ozs. each, Nos. 21-26; 1 oz. each, Nos. 27 to 31; ½-oz. each, from Nos. 32 to 36; and ¼-oz. each for Nos. 37, 38. This last and smallest number weighs 4 ozs. per sq. ft.

The American, or Brown & Sharpe, standard wire gage increases in regular geometrical progression. No. 4-0 is the largest number, and measures .46-in. The smaller numbers are found by deducting from the next higher value 10.9478%. down to No. 36, which measures .005-in. The American Standard screw gage is used for determining by numbers the various sizes of wood and machine screws. The difference between consecutive sizes is .01316-in. The Birmingham wire gage, the oldest and best-known gage, was devised by Mr. Holtzapffel in 1843, and published in 1847, and subsequently adopted as a standard by the Board of Trade. The series of numbers ranges from .454 to .004-in. in measurement. The Whitworth Standard wire gage ranges from 1,1000 to .5-in. in 62 measurements, all expressed in 1,000ths of an inch. While the numbers in this scale do not advance consecutively, it has the undoubted advantage of directly indicating the actual measurement. The British Legal Standard gage was recommended by the Board of Trade, and by order of Council it went into effect on March 1, 1884.

After discussing the form and material of gages, the variation of these gages from wear in use and from carelessness in manufacture, and the trouble arising from these causes, the author proceeds to describe his comparometer, here illustrated. This device is intended for comparing different standards; though, incidentally, it will determine standard dimensions, numbers of standard gages and various co-related properties of objects depending upon their dimensions. It combines a micrometer caliper, of English and metric division, with various current gages for wire, plate, drills, etc.; it gives the weights for round and sheet metals;

the number of threads per inch for standard machine screws, and tap-drills for the same; and it furnishes the means for comparing any of these at a glance. The mechanical principle involved is that of a plane spiral base combined with a radius-vector, movable around its pole. The shifting of the radius-vector causes some fixed point on it to recede from, or advance toward the spiral; with a rate of recession or advancement in direct proportion to the arc traversed. The pitch of the spiral in this instrument is ½-in., and the space between the circumference of the base and the adjusting screw of the radius-vector, or indicator arm, gives an equivalent range of measurements.

The divisions on the base all represent a limit between 0 and ½-in. for the whole revolution; and all the division numbers are marked above their respective division lines to facilitate reading without shifting the indicator. The 1-in. circle, being divided into 500 equal parts, each of its divisions represents 1-1,000 in.; and the vernier attached to this circle enables us to read off directly to 1-10,000-in. The Brown & Sharpe gage circle has double divisions; those on the outside are in direct proportion to the inch and to the metric circle; the divisions on the inside are tenfold enlargements of the former, and add another decimal to the inch and metric scale, when compared therewith. The steel music wire gage represents numbers from 8-0 to 30, and ranges in size from .0083 to .08-in. The Stubb steel wire and the Twist Drill gages are nearly alike, and are placed on one circle, inside and outside. In computing for the weights of copper and iron, on the outside of the largest circle, copper is taken at 555 lbs. per cubic foot at 8.89 specific gravity; and iron at 450 lbs. per cubic foot at 7.69 specific gravity.

This Comparometer replaces all the gages marked on its face; and combines a micrometer caliper with one or all of these gages, for accurate measurement, with divisions of 1-1,000-in., 1-64-in., and 1-100 millimeter. As an example of its wide use the author places a piece of copper wire between the spiral edge of the instrument and the micrometer screw. On looking along the straight edge of the indicator we find the following data for this wire: It is No. 4 B. & S. wire gage; measures 13-16-in.; is compared with No. 11 Standard machine screw; 24, 28 or 30 threads per inch; compares with No. 21, 20 or 19 Tap Drill; No. 26 Twist Drill; No. 5 Stubs steel wire gage; No. 6 B. wire gage; measures 0.2043-in.; equals 126½ lbs. per 1,000 ft. (for copper wire).

The author deals with the much-discussed subject of the introduction of the metric system of measurements into ordinary shop practice; and he believes that the difficulties encountered are largely caused by the lack of some means for leading this innovation into the shops. In regard to wire gages he would throw aside all that do not advance by regular steps; leaving only the B. & S., the U. S. Standard, and the Whitworth gages. Of these the B. & S. is the only one in which the consecutive numbers advance uniformly; but the other two have peculiarities that are useful. The dimensions on the B. & S. gage, however, give no even numbers in customary common fractions, nor in thousandths of an inch; yet they are all multiples of 1-2,560-in.; and with the exception of Nos. 32, 34, 36 and 37, they are all multiples of 1-640-in. But by comparing this 1-2,560-in. with 1-100 millimeter, we find that they differ only by about .08%; therefore, if the dimensions of the various numbers on this gage were expressed in hundredths of a millimeter, this .08% difference would never be exceeded. This would bring us within the limit of the law of March 3, 1893, which permits a variation of 2½% either way in applying the standard gage "hereby established." In thus giving the dimensions for the various numbers of the U. S. Standard gage, there would not be a variation by actual measurement exceeding 5-1,000 of a millimeter, or .0001968-in.

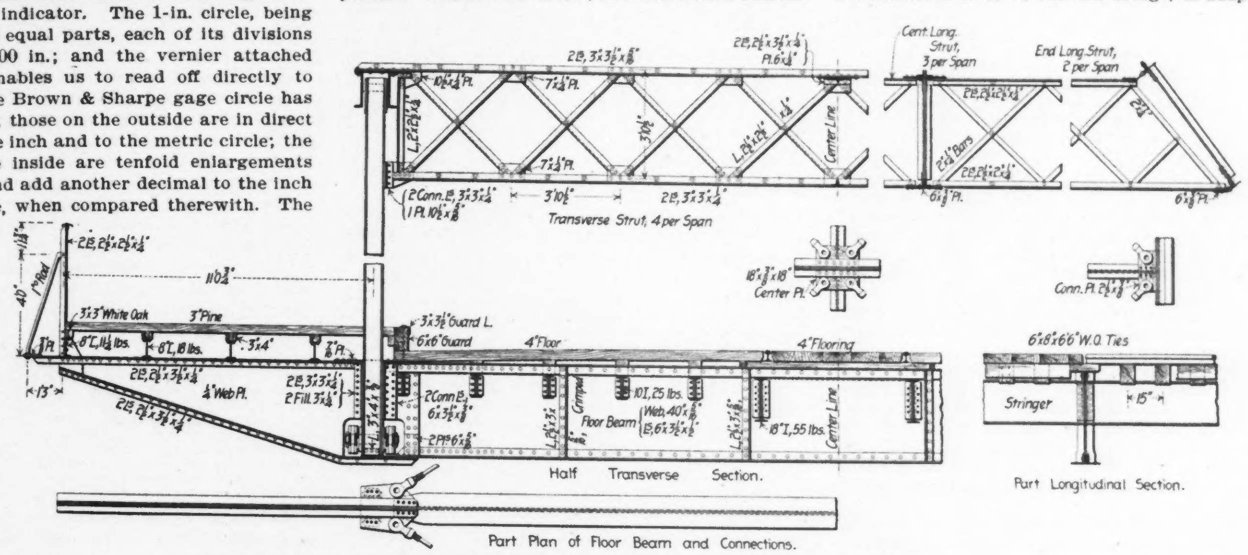
The author closes by presenting two valuable tables; for the U. S. Standard gage for sheet and plate iron and steel. The first gives the gage number; fractions of an inch; decimals of an inch; decimal parts of a millimeter; hundredths of a millimeter; weight per sq. ft. in ounces and in pounds. The second tables, in a somewhat similar manner, compares English and metric weights and measures. In each table the thickness of the plate ranges from ½-in. to 1-160-in. The author notes that in the American Standard screw gage we have unconsciously adopted a standard in closer touch with the metrical system than any system ever proposed. The consecutive sizes advance practically 1-3 mm.; or, 1-3 mm. equals .0131233-in., and the difference in consecutive sizes in this standard is .01316-in., the difference being only .0000367-in.

The inventor of the comparometer, Mr. S. H. Stupakoff, of Pittsburg, Pa., writes us that this instrument is not yet on the market. It seems to be so useful and convenient a universal gage, however, that it is to be hoped that some instrument maker may undertake its manufacture.

A HIGHWAY BRIDGE FLOOR OF ROCK ELM.

The city of Eau Claire, Wis., is constructing a steel highway bridge across the Chippawa River, which will be completed about April 15, and will be one of the heaviest structures of its type in the state outside of Milwaukee. It is made up of two middle spans of 146 ft. 5 ins. and two end spans of 144 ft. 10½ ins., all of them through pin-connected trusses. The piers and abutments are masonry; the piers are founded on piles and rip-rapped. These foundations were built by Charles Stone, of St. Paul, Minn. The superstructure, for which the Milwaukee Bridge and Iron Works has the contract, will contain 922,600 lbs. of steel, and there are 160,500 ft. B. M. of timber in the deck flooring, nailing strips and street car ties. The bridge is designed for a live load of 100 lbs. per sq. ft. on the roadway floor; 80 lbs. per sq. ft. on the sidewalks; and 4,000 lbs. per lineal foot on trusses; and the stringers under the car track are to carry a 20-ton car on a 7 ft. 6 in. wheel-base. Cooper's specifications of 1896 were used for all steel work, and the assumed dead load is 2,400 lbs. per lineal foot. When completed this bridge will be painted with two coats of carbonizing coating as made by the Goheen Mfg. Co. The cost of the foundation was $19,960, and that of the superstructure $26,175, or $46,135 in all.

The roadway, which is here illustrated, is 31 ft. 6 ins. wide in the clear, with two 10-ft. sidewalks. The roadway itself is made of 4-in. rock elm, surfaced on top and having a 2½-in. crown; the ties are white oak, 6 x 8 ins. and 6 ft. 6 ins. long, spaced 15 ins. between centers. On these is placed the 60-lb. T-rail of the street car line. This arrangement of floor, without pavement, is regarded as posessing many advantages by the engineer, Mr. C. A. Alderman, Assoc. M. Am. Soc. C. E., the City Engineer of Eau Claire, to whom we are indebted for the information made use of in the preparation of this article. It will be also noted that the 8-in. gas pipe, which formerly rested on the sidewalk floor of the old bridge, is suspended from the I-beam forming one of the stringers for the sidewalk floor; the suspending hooks are 10 ft. apart.



CROSS-SECTION OF FLOOR OF KELSEY STREET BRIDGE, EAU CLAIRE, WIS.

C. A. Alderman, City Engineer. Milwaukee Bridge & Iron Works, Contractors.

The piers and abutments of this bridge contain 2,020 cu. yds. of Winona limestone; 211 cords of Dunnville sandstone were used for riprapping the piers; 40,000 ft. B. M. of white pine were used in the grillage under the piers. The grillage was built in the form of a caisson, with 2-in. plank sides, and was sunk upon the piling. The general design for the bridge was made by Mr. Alderman; but Mr. J. B. Marsh, of Des Moines, Ia., made the detail drawings for the superstructure. The bridge replaces an old combination bridge, built 14 years ago, with 18-ft. roadway and two 8-ft. sidewalks. The old bridge was condemned as being too light for the heavy electric cars which will cross the new structure.

AN ELECTRIC RAILWAY FOR THE USE OF REligious pilgrims to the shrine of Ste. Anne de Beaupre is being constructed between Quebec and Ste. Anne de Beaupre, Quebec. The distance is 28 miles, and formerly visitors to the shrine were carried on a steam road which is now being converted to an electric system. The operating plant will include one 600-K-W. alternating current-direct current generator, two 300-K-W. self-cooling step-up transformers, complete switchboard for the generating station, one 200-K-W. rotary transformer, two self-cooling transformers, also complete sub-station switchboard—all furnished by the Westinghouse Elec. Mfg. Co., Pittsburg, Pa. Also 25 cars which will be manufactured at Ahearn & Soper's car works. The small cars will be equipped with 30-HP. Westinghouse motors, and the long cars, which will have 4 50-HP. Westinghouse motors, will be used between Quebec and Ste. Anne de Beaupre. The traffic of this road is unique from the fact that it consists almost wholly of pilgrims to the shrine of Ste. Anne, situated in the church of the same name at Ste. Anne de Beaupre. This church contains a piece of bone which is said to have been taken from the arm of Ste. Anne, the mother of the Virgin Mary, and miraculous cures are reported in connection with the halt and blind who visit the church, one end of which is piled high with crutches left there by those who have been cured. The traffic during the summer months is large, but it is thought that the electric service will greatly increase it.

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CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
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ADVERTISING RATES: 20 *cents per line. Want notices, special rates, see page XIX. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.*

The purchase of an American bridge by the British War Office to carry the Waddy Halfa-Khartum military railway across the Atbara River in the Sudan, has stirred up a few English newspapers and manufacturers to say some very foolish things, if the press dispatches from London are to be credited. We noted the main facts of this contract in our issue of March 30, but they will bear a brief repetition in connection with the latest developments which we have just mentioned. As already stated, the bridge across the Atbara River was required in connection with the present British military operations in the Sudan, and its quick delivery and erection were far more important considerations than its cost. The attempt was first made by the engineer officers of the army forces under Lord Kitchener to place the order for the bridge in England, but no English bridge builder would guarantee to do better than 6½ months in the time of delivery. This being considered too long a time to wait for the work, it was then decided to try American builders, with the result that the Pencoyd Iron Works, of Philadelphia, Pa., accepted the contract to deliver the bridge on board the cars in 42 days, and did actually deliver it in 40 days. The total weight of the structure as delivered was approximately 800 tons, and its design and type were left to the builders, except that it was specified that the bridge should be erected without falseworks, the Atbara being a torrential stream, subject to sudden heavy floods. From these facts it will not strike American engineers generally, we think, that there was anything extraordinary about this work, but it seems to have acted upon English bridge builders somewhat like the proverbial red rag on a bull, and their feelings seem to be mild as compared with those expressed by the English daily papers. Indeed, one of the leading London dailies could explain the underbidding of the English bridge firms only by

> the habitual animosity shown by the Khedive and his Government to their habitual protectors. If the bitter antipathy to British engineers revealed in these proceedings cannot be traced to the Khedive and is the result of foolish and unpatriotic prejudices upon the part of his English advisers, the sooner those advisers are brought to book the better.

This "Egyptian War Office Scandal," as the article was headed, was punctured almost immediately, however, by the news that the engineers under General Kitchener, and not the ungrateful Khedive, were responsible for the discrimination against the home manufacturers. To the American engineering reader, however, the really delicious feature of the whole matter is the widely published interview with Mr. Rigby, of the firm of Rigby & Westwood, one of the English bidders for the bridge. Mr. Rigby's remarks, as given in the press dispatches, were as follows:

> I simply do not believe that any firm in the world can turn out a bridge of that size in the time mentioned. We and other British firms made special efforts to secure this particular contract. At a meeting of our Directors, who are all connected with large steel mills, it was agreed to divide the supply of the requisite material and let other orders wait. We made a very low tender, guaranteeing to deliver the bridge by April 30, but no tenders of British firms were even acknowledged. Of course, a bridge has undoubtedly been shipped from Philadelphia, but I absolutely decline to believe that the work on it was commenced on Feb. 8. The American firm either had the specifications before, or adapted a standard bridge to suit the requirements of the case. No other explanation is possible. The general feeling is that the British firms have been unjustly treated.

In another interview, Mr. Westwood, of the same firm, elucidated the matter a little further by the following statement, which will, we think, have a familiar sound to the ears of American engineers:

> The British tenders were higher because special girders were required, which were dropped in the case of the Americans, who were allowed to supply a pin-bridge, which good English engineers have utterly discarded because it makes a weak bridge.

Really, however, there seems to be very little sense in this tempest in a teapot. If, as has been said, the English builders had so many orders ahead that they could not turn out the Sudan contract sooner than six or seven months, they certainly are in a fortunate way, and cannot suffer greatly from the loss of that work. If, on the other hand, they cannot compete with the American builders in turning out work rapidly, there is no one at fault but themselves. The celerity of the Pencoyd Iron Works in this case is not a whit more remarkable than that of the various American locomotive works, who have been taking large orders in the English market because they are able to make a more speedy delivery than the English builders. The fact is that American builders are prepared to be called upon to build locomotives and bridges at very short notice on frequent occasions where expedition is of more account than cheapness, and, as in the case of the Atbara bridge, and the recent French and English locomotive contracts, they do it, and, moreover, they furnish work of such high excellence as to attract the continued patronage of their foreign customers. This is the whole explanation of the "American invasion of the European market," about which the newspapers on both sides of the Atlantic have recently expended so much unintelligent discussion.

The legislative investigating committee which has been probing into the methods of the New York Building Department, with respect to its treatment of various rival fireproofing systems, is making some interesting disclosures. This journal has long been aware that exceedingly questionable practices obtained in this matter in New York city, and has fought first and last against the unfair and indefensible partiality shown by the Board of Examiners toward certain fireproof constructions to the exclusion of others which were held by the majority of engineers to be just as good, but which for easily imagined reasons were not approved by the powers that be. That we were sufficiently warranted in taking this stand is fully proved by the evidence of the very first day's investigation, which the Committee has made of Building Department practices. We call particular attention to this matter at this time for the reason that some of our readers, who did not know the circumstances, have criticised us for censuring the Building Department officials on what they supposed to be no more justifiable a basis than a personal prejudice against certain materials and types of construction which enjoyed official favor. It has happened, unfortunately perhaps, that in taking the course we did we have had to point out the weaknesses and criticize the faults of individual fireproofing systems in a very prominent manner; but it is needless to say that this journal does not champion one material or method of construction beyond any other except in so far as it shows itself better suited to the purposes for which it is intended. Regarding the present investigation, we will only say at this time that as those of our readers who are most interested in questions of fireproofing and building construction in New York city, have full access to the evidence through the daily press, we shall reserve a complete discussion until the investigation has made farther advancement. We advise all our readers who can do so, however, to read the evidence in full as it is presented from day to day.

It is a pleasure to note that the new mayor of Philadelphia, Mr. Samuel H. Ashbridge, has taken a determined and intelligent stand on the water supply question. His first official utterance, aside from his inaugural address, is a message to the city councils devoted to improvements in the water supply. His diagnosis of the case is accurate, and his prescription correct. He says waste must be stopped; that menace to the safety and efficiency of the plant must be removed by making long-neglected repairs and improvements; and, most important of all, that a commission of experts, with an ample appropriation, should be appointed at once

> charged with the duty of examining the most available sites for installing one or more filtration plants, and who shall present a preliminary report within 60 days upon the feasibility of the system for one or all of the pumping stations, together with the total estimated cost thereof, and such other information as may seem pertinent on the subject of the improvement and extension of the water supply as provided in the Loan bill, the final report to be ready for presentation to your honorable bodies immediately after the usual summer recess.

Had such a commission been appointed a year ago, some parts of Philadelphia might already have a pure water supply. The problems involved demand careful study by the best authorities on water purification. Such men the mayor asks power to select, and he has given reason to believe that his choice will commend itself to the engineering profession and the public. Three experts on water purification, acting with such men as are now at the head of the Department of Public Works and the Bureaus of Water and Surveys, could work wonders in cleaning the thick atmosphere that has been surrounding the water question for months, and even for years. In fact, we think the mere appointment of such a Commission would be followed by a lifting of much of the fog of doubtful motives and the smoke of battle of contending factions which have so obscured the water horizon for a long time past.

We are glad to record a revival of hope for some legislation to protect the purity of the water supplies of Pennsylvania. A new bill to that end has recently been introduced in the State legislature. To remove the opposition of manufacturing and mining industries, which were largely instrumental in killing the first bill, the act now proposed refers only to household wastes. It authorizes the State Board of Health

> to examine the water supplied to municipalities of this Commonwealth for domestic uses, for the purpose of ascertaining whether said water is free from Human Dejection (sic).

In case such contamination is found the Board is to attempt to trace it to its source, but a warrant must be secured for entering on any property to make the necessary examinations. When any pollution is located the offender is to be notified to abate it within a stipulated time. If this is not done the local board of health is to abate the cause of pollution under the direction of the central board. In case the local board does not act, or none exists, then the State Board is to act in its place. The expenses involved in the abatement of pollution are to be borne by the offender. So mild a measure as this ought to be passed by the Pennsylvania legislature unanimously. While much good work could be accomplished under it, far more might be done if a little more authority were

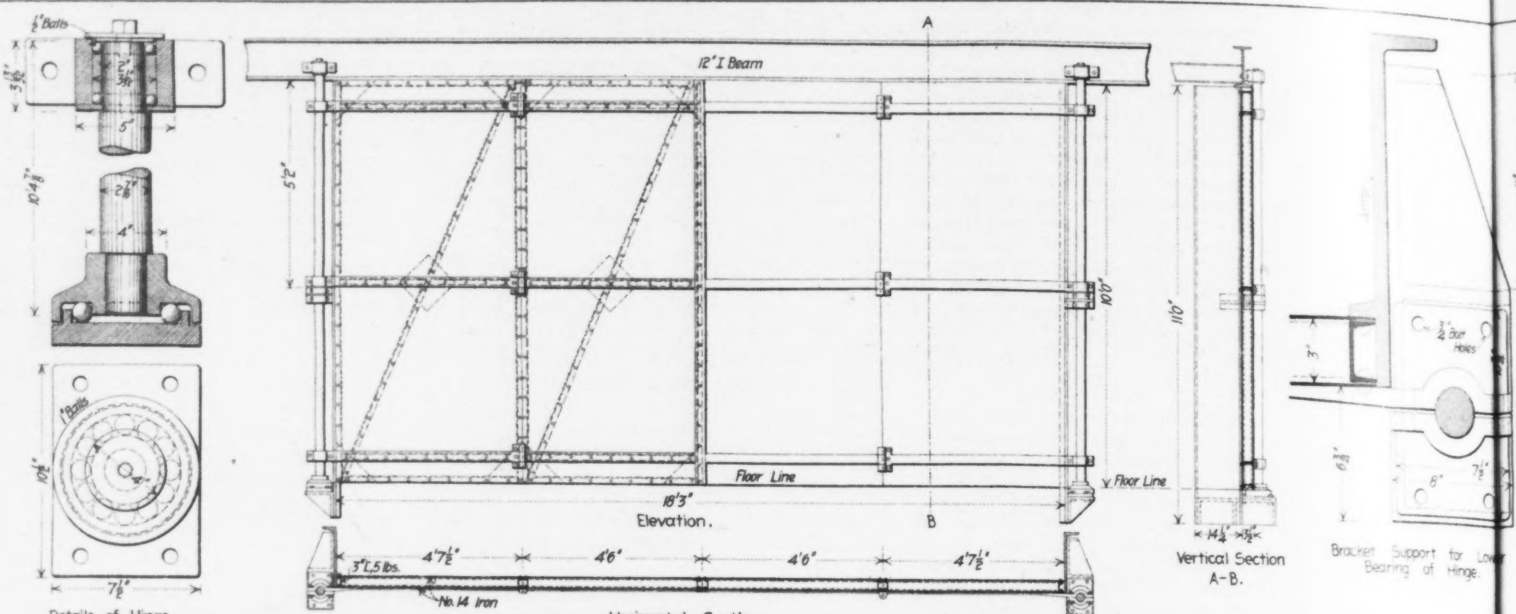


FIG. 5. DETAILS OF SWINGING DOORS FOR LARGE CORE OVEN.

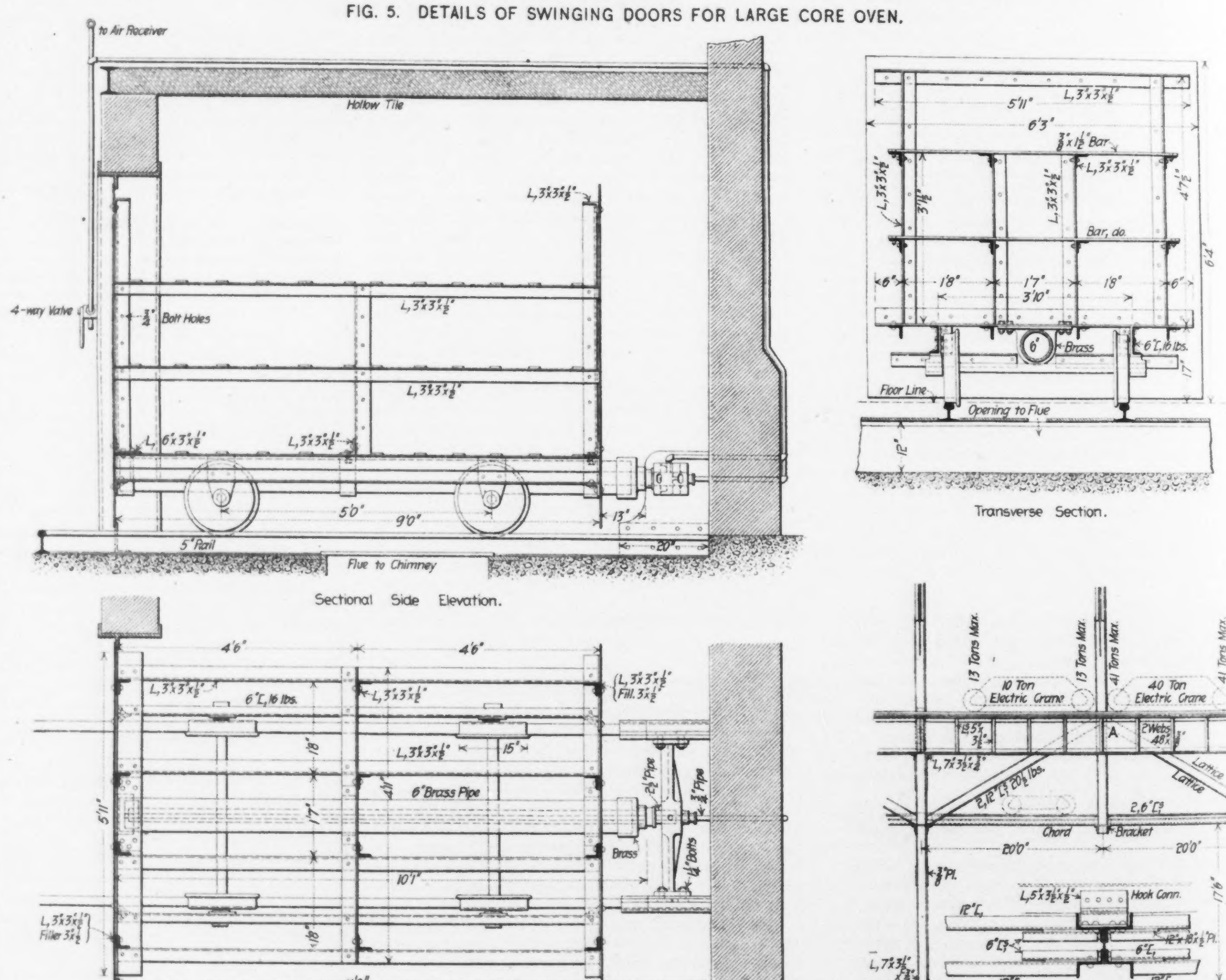


FIG. 6. MOVABLE RACK FOR SMALL CORE OVENS, OPERATED BY COMPRESSED AIR.

THE NEW IRON FOUNDRY AT THE WORKS OF THE GENERAL ELECTRIC

G. E. Emmons, General Manager Schenectady Works.

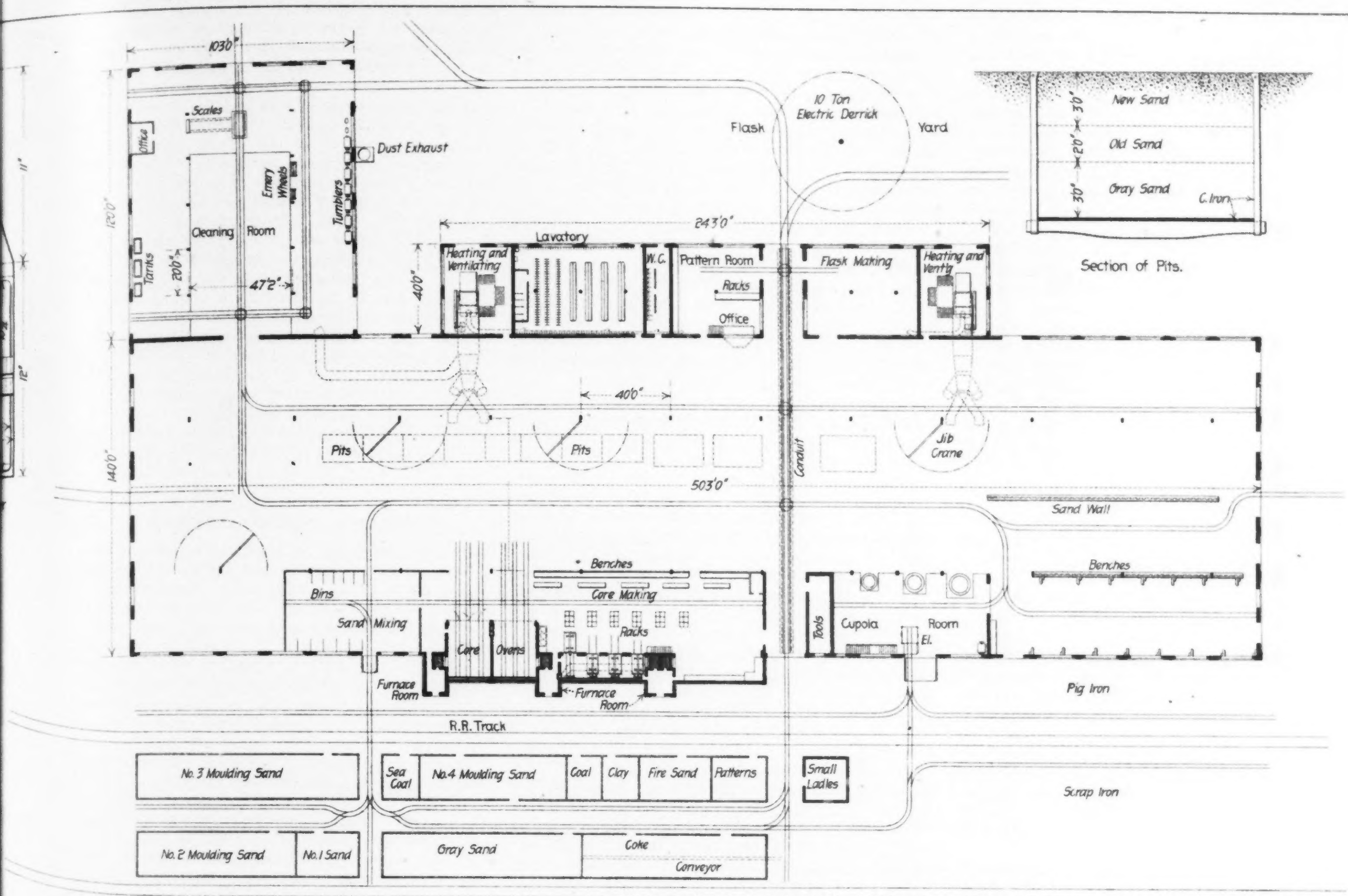
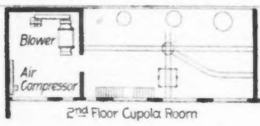


FIG. 3. FLOOR PLAN, SHOWING GENERAL ARRANGEMENT.



2nd Floor Cupola Room

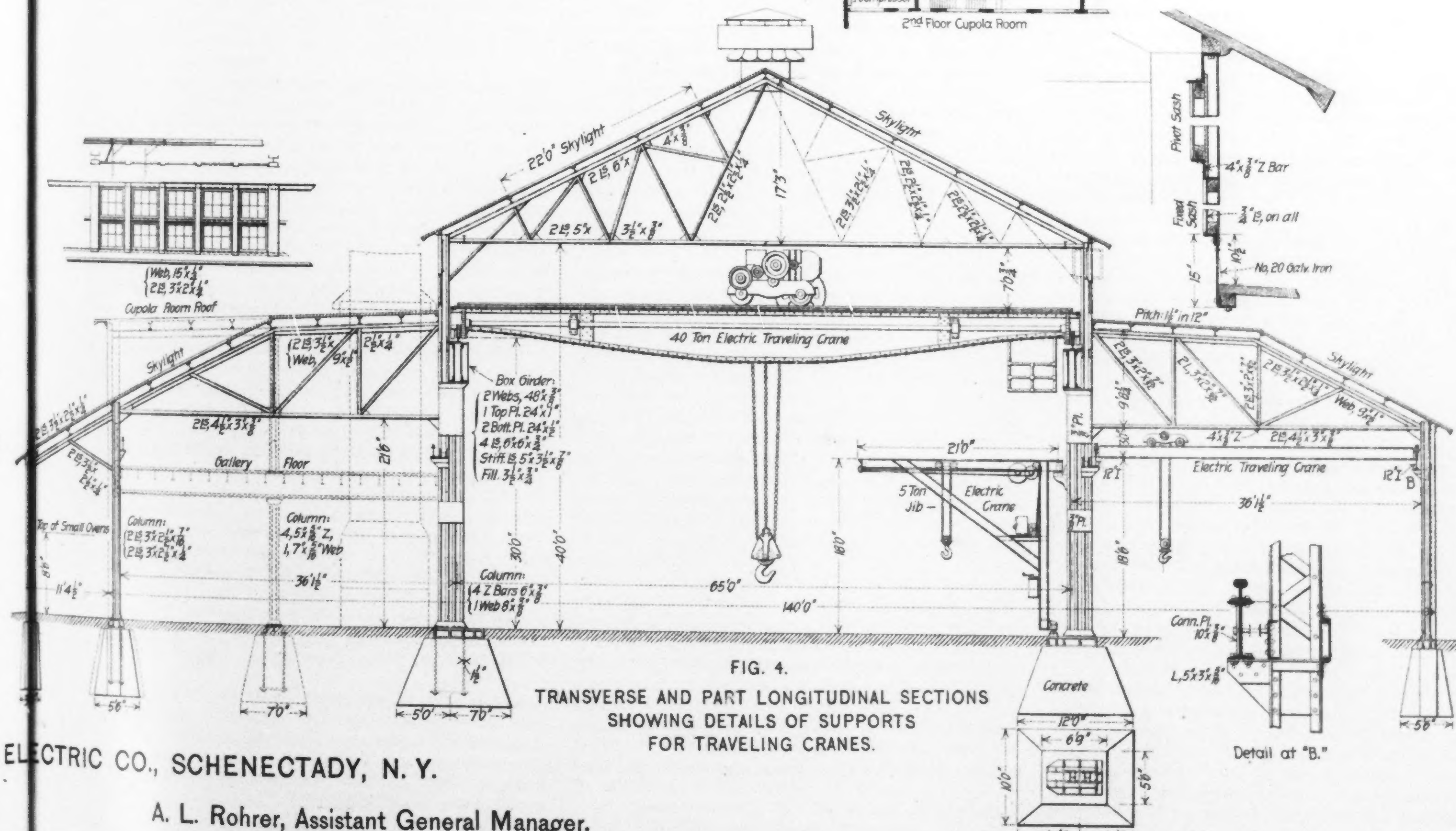


FIG. 4.
TRANSVERSE AND PART LONGITUDINAL SECTIONS
SHOWING DETAILS OF SUPPORTS
FOR TRAVELING CRANES.

Detail at "B."

AL ELECTRIC CO., SCHENECTADY, N. Y.

A. L. Rohrer, Assistant General Manager.

CHAS. HART, LITH., 36 VESEY ST., N. Y.

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given the Board, and a different mode of initiative provided. As the bill reads, the Board seems to be expected to discover pollution by analyses, making inspections only to verify what its analyses lead it to suspect. In many instances the more rational procedure would be to make the inspections first of all, and as a general rule inspection and analysis should at least go together. A more serious fault of the bill is its utter inadequacy as a measure to prevent pollution from municipal sewerage systems. In fact, it is doubtful whether it is intended to include such pollution, for "person or corporation" is the language used in designating possible offenders, and probably municipal corporations are not meant. Obviously local boards of health, or even the State Board, would be quite helpless in case a city refused to stop polluting a water supply, and the only remedy was the construction of a sewage purification plant. A further deficiency in the bill is that it carries no appropriation, without which little could be accomplished. Perhaps a separate appropriation will be made. Notwithstanding these weak points, great comparative advance would be made by the passage of the bill, and we hope it, or some improvement on it, will become a law.

A QUARTER-CENTENNIAL ANNIVERSARY.

Twenty-five years ago, on April 13, 1874, the first number of Engineering News was published. It was started as a monthly journal of 16 pages, under the title of "The Engineer and Surveyor," and in the second issue this was changed to "The Engineer, Architect and Surveyor." It was not until the issue of January, 1875, that the name was changed to "Engineering News," and not until the beginning of 1876 was it changed to a weekly journal. Nevertheless, since its publication has been continuous from the start, it is correct to consider the founding of Engineering News as taking place with the first issue of that modest little monthly, on April 13, 1874.

As many of our readers are aware, this journal was founded by Mr. Geo. H. Frost, now the President of the Engineering News Publishing Co. During the seven years from 1867 to 1874 Mr. Frost was in practice as a city land surveyor in Chicago, and he became impressed with the idea that a demand existed for a journal to be devoted to the interests of civil engineers, and particularly to land surveyors. During the dull times of the panic year of 1873 he matured his plans, and finally brought out the first number on the date above named.

The little journal was first published at 145 Clark St., Chicago, and the contents of the initial number make curious reading at the present day. The very local character of the journal at the outset is indicated by the "directory of the meetings of the city and town boards, and of scientific societies," which occupied the head of the first page, and which was confined strictly to Chicago. There was no cover, no illustrations, with the exception of one coarse wood cut of a patent trunk accompanying a "write-up," and only a column or so of advertisements.

The new venture started off with a bona-fide subscription list, secured by previous circulation of a prospectus; but it was naturally a very small one. The matter for the first issue was prepared by Mr. Frost during evening hours, after completing his day's work as a surveyor; a relative engaged in the printing business arranged for the composition and presswork, and Mr. W. F. Goodhue, C. E., afterward City Engineer of Racine, Wis., attended to the distribution of the printed copies. The only contributed articles were some rather general dissertations on "Irrigation" and "The Pollution of Water," by Mr. Chas. J. Moore, a young English civil and mining engineer, then resident in New York city. Mr. Moore afterward removed to Chicago, and assisted Mr. Frost in editing the succeeding issues until the close of the year.

In the fourth issue, published in July, an inset sheet was inserted, "Examples of Sewers and Faults in Building Them." It was a lithographed, double-page plate, drawn by the editors themselves as a legend upon it testified. This was not only the first inset, but the first illustration to appear in the paper, if the patent trunk above referred to be excepted.

The new journal was started with a subscription price of $2. This was reduced at the beginning of the second volume to $1. Two years' experience, however, showed that a monthly journal of such a cheap price and cheap contents, circulating chiefly among land surveyors, could never pay its way, to say nothing of proving profitable. At the beginning of 1876, therefore, Mr. Frost took the bold step of changing to a weekly journal, increasing the size of the page to that which is at present used, raising the subscription price to $2.12, and appealing to civil engineers generally for support. He was encouraged in this course by the friendship and patronage of several prominent engineers, and he secured the aid in his editorial works and as a special contributor, of Prof. Chas. E. Greene, M. Am. Soc. C. E., then and now Professor of Civil Engineering in Michigan University. The journal in its new form showed great improvement. Articles were contributed to its columns during the first year by Prof. Mansfield Merriman, Lyman E. Cooley, then a professor at the Northwestern University, Geo. W. Rafter, of Rochester, N. Y., and a number of other engineers engaged in active practice. Mr. Cooley became a salaried editor of the paper on July 1, 1876, and continued in the position for a year, finally resigning to take a position in connection with the construction of the Glasgow Bridge, in Louisiana, under Gen. Wm. Sooy Smith.

For the first two years while Engineering News remained a monthly journal, its revenues were exceedingly small. Its subscription list was, of course, limited, and it secured practically no advertisements save that of one or two makers of surveyors' instruments. During these years Mr. Frost continued his work as a surveyor to earn enough to meet his family expenses and the monthly deficits of his journalistic venture. After the change to a weekly edition was made, the demands upon its owner's time increased so that he was obliged to abandon his surveying. With the change in form and the great improvement in the character of its contents in 1876, advertising patronage began to increase, and was influenced especially by the inauguration of a "construction news department," on a very modest scale, to be sure, but a valuable aid to contractors nevertheless, in those early days of engineering journalism. By the close of 1876, the paper contained two full pages of advertisements, including at least eight firms which have been from that date to the present time advertisers in its columns. It may be noted here that in the first number of this journal there was published a half-column advertisement of Wm. J. Young & Sons, Mathematical and Engineering Instrument Makers, of Philadelphia. This firm has advertised continuously in Engineering News throughout the entire quarter century since that time.

Until July 1, 1876, the advertising and reading pages were not separated. After that separate pages for advertising were placed in front of and behind the reading matter, so that the latter could be separated for binding, and the paper then assumed a form which it retained for some eight years, until the addition of a colored outside cover at the beginning of 1885. The reading matter was increased to 12 pages early in the '80's, and to 16 pages at the same time that the cover was added. This included the construction news departments, society proceedings, etc. In 1887 the reading matter was increased to 20 pages, and in 1889 to 24 pages. The subscription price when weekly publication was first begun was $2.12. This was raised to $3 at the end of six months, to $4 in 1882, and to $5 in 1884.

The paper was published in Chicago from the date of its establishment until December, 1878. Besides those above-mentioned, Mr. John W. Weston was a prominent colaborer of Mr. Frost's during early years in Chicago, having practically entire charge of the business department during two years, when Mr. Frost was engaged as the assignee of a hardware business. Among prominent editorial writers were Messrs. Clemens Herschel, R. F. Hartford, and the late Prof. Chas. A. Smith, of Washington University, St. Louis.

In December, 1878, Mr. Frost put into effect a plan which he had had for some months in mind, and removed the publication to New York city, taking an office in the Tribune Building, which was then the principal office building of the city. This building remained the location of the chief publication office until 1897, rooms being occupied first on the ground floor, and later on the sixth and seventh floors, until finally more room than was there attainable became requisite, and the offices were removed to their present location, in the St. Paul Building, in May, 1897. The Chicago office was given up when the paper removed to New York, in 1878, and was not re-established until 1893.

During the early years in New York various scientific journalists were connected with the paper in an editorial capacity, among them being Messrs. Park Benjamin and S. D. V. Burr. Col. Julius W. Adams, Past-President, M. Am. Soc. C. E., was also for a short time the chief editor. The valuable features of the journal, however, were its contributions and correspondence from practicing engineers, and its reprints of papers read before engineering societies. In 1882, Mr. Frost, who had up to this time, retained sole ownership of the journal, disposed of a half interest in it to Mr. D. McN. Stauffer, M. Am. Soc. C. E., who assumed charge of the editorial department, while Mr. Frost devoted his time to the business management. The next five years were years of rapid growth. In 1887 the late A. M. Wellington, at that time, doubtless, the most brilliant and capable of American engineering writers, was added to the editorial staff, and became also one of the owners. The improvement which followed his advent is still too recent in the minds of many readers to call for detailed statement here.

The more recent history of the journal, it is not our purpose to follow at this time. We have merely deemed it appropriate at the completion of the first quarter-century of this journal's life to give to our readers some glimpse of its earliest years, and of the circumstances under which it was founded.

At the outset, as has been remarked above, it was the idea of the founder to make it a journal especially for land surveyors; less than two years' experience, however, led to a broadening of its scope to cover the field of civil engineering generally, using that term in the sense in which it is commonly employed. In 1887, when Mr. Wellington joined the editorial staff, the field was definitely enlarged to include railway and general mechanical engineering. With the growth in the journal since that time the policy has been gradually formed and fixed of covering the whole field of engineering, selecting from the entire body of current engineering literature, in whatever form it may be presented, that which the editors in the exercise of their best judgment, conceive to be of the greatest interest and value to their readers. It is often said, and with truth, that in modern life the tendency is more and more toward specialization. The young engineer who would succeed in these days of close competition must perfect himself in one particular branch of his profession. Yet if he does this and nothing more, he sets a limit to his growth and advancement. The tendency of too close specialization is to narrow the mind and narrow also the possibilities of usefulness. The great rewards in the engineering profession do not go to the specialists; but to those whose breadth of mind and whose character and ability fit them to occupy executive positions.

Besides this, no hard and fast line can be drawn between the different specialties into which the engineering profession is divided. In the development of a water power, for example, civil, mechanical and electrical engineering must all co-operate if the best results are to be reached. The chief engineer of such an enterprise needs at least sufficient knowledge of all these to direct and to pass upon the work of his subordinates in each line.

It is with these things in mind that Engineering News aspires to aid its readers by keeping them informed of current progress in all departments of engineering work. It has been its policy, moreover, to avoid, on the one hand, articles of merely popular interest, and on the other hand, articles which deal with pure theory or mathematical abstractions. The matter for which the editors are at all times in search is that which will be of practical value to the working engineer. Engineering News aims, on the one hand, to give to its readers what the title of the journal implies, the current engineering news; and, on the other hand, to publish articles of such permanent interest that the bound volumes of the journal will form a valuable reference library.

In this connection, it may not be inopportune to remark that to increase the usefulness of our back volumes to those of our readers who have preserved them, we propose, upon the completion of the present year, to publish a complete index to these volumes, covering the ten years 1890 to 1899, inclusive. Fuller announcement of this work will be made at a later date. We call attention to it here merely as a matter which we are sure will interest our readers who find difficulty in searching through the half-yearly indexes to find the articles which have been published during some years past upon a particular subject.

We have alluded above to the breadth and scope which this journal aims to give to its treatment of engineering subjects. Perhaps we can define its policy still more broadly by saying that its purpose and aim is to labor for the upbuilding of the engineering profession, using that term in its broadest sense. The growth and prosperity of this journal have closely coincided with the growth of the profession of engineering, and the enlargement of its scope and field of work. We are of those who believe that this growth has only begun. A quarter-century ago the engineer was still to a large extent merely the man with compass and transit and chain—a skilled workman in making exact measurements, and little more. The public appreciation of the engineer has greatly advanced since that day; and the engineer is better deserving of appreciation; but there is still much room for improvement. The public is slowly awakening to the value of expert advice, and to the value of experts whose sense of professional honor and honesty makes their advice worthy of confidence.

It is to the task of making a professional journal which shall be a worthy exponent of the engineering profession, and which shall aid in securing for that profession the high standards and the honorable reputation which it deserves to hold, that we address ourselves; and we look toward the future with all confidence.

LETTERS TO THE EDITOR.

The Spacing of Stiffeners in Plate Girders.

Sir: Allow us to send you some remarks about the experiments of Mr. H. T. Beach on spacing stiffeners in plate girders, published in Engineering News of Feb. 16, 1899. Mr. Beach tells us that his experiments show the web plate of the stiffened girder to be destroyed by tension. Referring to the engravings accompanying his letter, we call your attention to girders F, G, H, I and K, where the webs are not yet torn, but only buckled. You will agree with us, that a buckled web plate is already destroyed in an engineering sense, because the resistance of it to exterior strains is practically zero. Therefore we come to a conclusion just contrary to Mr. Beach's, viz., the web plate of stiffened plate girders is destroyed by compression strains acting in the general direction of the diagonals of the panel, formed by the flanges and the stiffeners, as shown by the accompanying diagram.

This is also quite easy to understand from a theoretical point of view: The resistance of iron to compression strains is less than to tensile strains as soon as the thickness of a piece to its length exceeds a certain value (generally taken as 40 to 50). That, indeed, is the case in the web of the plate girders, so that the destruction must be caused by compression because the resistance of iron to bending strain is taken equal to that to compression and tension. These facts are very familiar to every engineer who uses the formula of Rankine, or others of that kind, and that they are understood in this sense is shown by the inclined position of the stiffener, very common in American bridge construction.

Yours respectfully,
William A. Russell,
Walter Rosenthal,
Students of the Institute of Roads and Communications, St. Petersburg, Russia.
St. Petersburg, March 29, 1899.

Concerning the Prismoidal Formula.

Sir: Mr. "W," writing in your issue of March 23, wishes to know "how many cubic yards there are in a 400-ft. rock cut having vertical sides 27 ft. apart and the cuttings of which at the regular 100-ft. stations are 5 ft., 33½ ft., 43 ft., 33 ft. and 3 ft.?"

"X" disclaims any intention of offending the supercility of the "practical engineer" in his criticism of "H. T.," nor did he think to lay himself open to the charge of hypercriticism by a mere allustion to the prismoidal formula. Neither did he wish to make it so very "evident that he can deduce the formula," but it is reasonable to suppose that if he can deduce the formula he knows when and how to use it.

$$v^1 - v = \frac{1}{6} [(h_1 - h_2) (h_1 - h_2) + a (h_1 - h_2)^2].$$

where
v^1 = volume by method of "average end areas,"
v = volume by prismoidal formula,
h_1 = center and side depth of level section No. 1,
and
b_2 = corresponding measurement for section No. 2,
b_1 = bottom width of section No. 1,
b_2 = bottom width of section No. 2,
s = side slope.

This formula, together with the cost of excavation, is the criterion by which to judge of the necessity of using the prismoidal formula. In the problem above $b_1 = h_2$, and $a = o$; therefore Mr. "W" need not use the prismoidal formula.

"X" will suggest, however, that if Mr. "W." is in the habit of taking no more data than that given above for the computation of rock excavation, it makes little difference whether he computes by the method of "average end areas," "prismoidal formula," or stands at a respectable distance and guesses at it; would suggest that he guess at it hereafter and let the prismoidal formula alone. A blacksmith has little use for a watchmaker's tools; neither would a man shoot snow-birds with a Gatling gun.

Respectfully, "X."
Vicksburg, Miss., April 4, 1899.

The Relations of Velocity and Pressure in Centrifugal Fans and Pumps.

Dear Sir: I have read with much interest the articles in Engineering News of March 9 on Centrifugal Fans and Pumps, one by Mr. Adams and one by the Editor.

Mr. Adams' conclusions seem wrong. His demonstration in the next to the last paragraph of his paper is certainly incorrect. The following discussion of the problem, as I understand it, brings out some relations very different from those assumed by the editor. We agree in our conclusions, but one or the other must have reached it by accident.

In this discussion I neglect friction, compression of fluids and pressures other than those produced by the pump, fan or blower.

Suppose the vanes A, B, C, Fig. 1, are revolving with a peripheral velocity v in a close fitting casing that has no outlet. Then the pressure on the casing at the outer limit of the vanes, due to the centrifugal force of the fluid between the vanes, and extending in to the axis, will be that due to a head $= \frac{v^2}{2g}$, as can be mathematically proved. Now open a narrow slot around the circumference of the casing, and fluid will pass out with a radial velocity v due to this pressure and at the same time will retain its tangential velocity v. Hence the absolute velocity of discharge through the slot will be $\sqrt{2 v^2} = 1.41v$ and its direction will be 45° outward from the tangent.

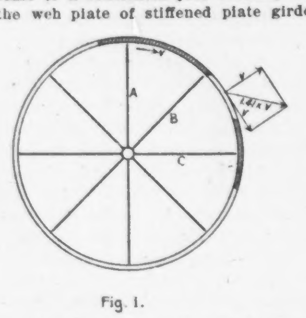


Fig. 1.

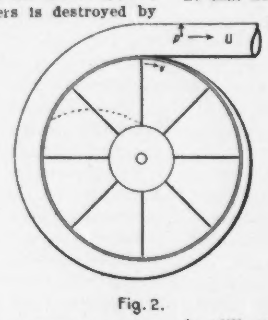


Fig. 2.

To consider conditions more nearly those of practice, let us take the type of machine shown in Fig. 2. Now, if the discharge pipe be closed while the vanes revolve with peripheral velocity v, the pressure in the discharge pipe, where the fluid is still, will be that due to centrifugal force at the outer ends of vanes (neglecting effect of friction, vortices, etc.). This is the greatest static pressure that can be produced with outlet closed; or the maximum static pressure equals $\frac{v^2}{2g}$.

Now open the discharge pipe so that there will be no restriction to the outflow. The pressure will disappear and the fluid will discharge with a velocity U. This discharge velocity is not equal to v but is dependent on it. Theoretically we ought to be able to make a machine in which $U = 1.41 \times v$ when all the work is absorbed in giving motion to the fluid.

If the discharge pipe is obstructed, as would be the case in working conditions, the useful work done by the machine can be found again near the entrance to the discharge pipe; but now there must be pressure as well as motion. Hence if W = weight of a cubic unit of the fluid, p = its static pressure per square unit, U = its velocity in feet per second and a = area of discharge pipe. Then useful work $= W a U \times \frac{U_2}{2g} + p a U$, which is a familiar hydraulic formula and may be stated thus:

Working head $= \frac{U^2}{2g} + h$, where h is the head in a piezometer tube inserted in the discharge pipe. In an ideal machine this sum should be constant if v is constant, and therefore should equal the velocity head plus the pressure head when the casing is closed as at first assumed; but in that case the pressure head due to centrifugal force is equal the velocity head due to revolution. Hence

$$\frac{U^2}{2g} + h = \frac{v^2}{2g} + \frac{v^2}{2g} = \frac{v^2}{g}.$$

Thus we find the greatest possible static head with outlet closed is $\frac{v^2}{2g}$; the greatest possible working head, or total head is $\frac{v^2}{g}$; and the greatest possible velocity of discharge is 1.41 v.

Both Mr. Adams and the editor assume the discharge velocity to be v or equal to the velocity of revolution, apparently confusing this case with that of a piece of solid matter detached from the outer end of the vane while revolving.

I should not leave the subject without pointing out that when the vanes do not extend in to the axis of revolution the proper formula for centrifugal pressure is

$$wa \frac{v^2}{2g} \left(1 - \frac{r_1^2}{r_2^2}\right)$$

where r_2 is the radius to outer limit and r_1 that to inner limit of vane. I should also say that the above discussion will not apply where the vanes are curved backward. It may be apropos to remark here that several well-known writers in treating reaction water wheels introduce centrifugal force in their formulas as if the water revolved with the wheel, when as a matter of fact the vanes can be so curved that there will be no centrifugal force whatever.

If the tests by Carpenter and by Buckie, referred to by the editor, were made by placing piezometer tubes radially in the casing they would have been effected by dynamic pressure if any discharge were taking place. (See Fig. 1.)

Very sincerely,
Elmo G. Harris.
School of Mines and Metallurgy, Rolla, Mo.
March 15, 1899.

ELECTRIC RAILWAYS IN GERMANY, says the "Electrotechnishe Zeitung," have grown as follows: In 1891 only three German cities had railways of this type; and on Sept. 1, 1898, 68 cities were so equipped, and in 35 other cities electric railways were being constructed, or were provided for. On that date the entire length of such roads in Germany was 888 miles, with 1,205 miles of track, 3,190 motor cars and 2,128 trailers. The length of new line then under construction or about to be commenced was 677 miles, with 830 miles of trackage. The electric street railway of Hanover, one of the first lines and now one of the best systems in existence, was built by an American engineer from Philadelphia and was opened on May 1, 1892. The cars are American in type and the heavy steel rails are laid on concrete. The fare, for a 2-mile course in the city, is 10 pfennigs, or 2½ cts. gold, with universal transfers. The speed is about 8 miles per hour; within the city, in some places, the accumulator system is used, outside and in the outskirts the overhead trolley is employed. The trackage is now over 105 miles, with 41 overhead trolley cars, 161 accumulator and trolleys combined, 167 trailers, 20 locomotives, 4 sprinklers and 24 freight cars. There are six power stations, four of them also providing electric light for the streets. The motor cars are from 17 to 20 HP.

A RADICAL CHANGE IN THE COURSE of the Ohio River, at Cincinnati, is being again discussed. The proposition is to divert the river by dikes into a new channel; commencing at the mouth of Four-Mile Creek, above Cincinnati, crossing the Licking River by means of a dam, and entering the Ohio again near Bromley, below Cincinnati. The estimated cost is $1,000,000, which seems very small. The geographical changes would be great, as the new channel would throw three large Kentucky towns and some small ones into Ohio. The tax duplicate of Cincinnati would also be increased by $90,000,000. What Kentucky has to say as to the proposed cutting out of her territory is not yet on record.

TRACK ELEVATION AND DEPRESSION AT SIXTEENTH AND CLARK STREETS, CHICAGO.

By Frank E. Snyder.*

The general plan for removing the complicated railway grade crossing at the junction of 16th and Clark Sts., in Chicago, was described in Engineering News of July 14, 1898. Briefly summarized, the conditions were a system of tracks crossing Clark St., from the southwest, near 16th, which handled the trains of all the companies using the Dearborn Passenger Station in Chicago, and also the freight traffic of these companies passing this point to their depots north of 16th St. The aggregate number of trains was 300 per day. There were six tracks crossing at an angle of about 60°, the four north tracks being owned by the Chicago & Western Indiana R. R. Co., and the two south tracks belonging to the Atchison, Topeka & Santa Fe Ry. About 100 ft. south of these tracks Clark St. was crossed by the St. Charles Air Line R. R., which handles the traffic of the Illinois Central and Michigan Central railways to the other Chicago lines; and branching from the Air Line in Clark St. were the tracks of the Chicago, Madison & Northern R. R., which handles the Illinois Central trains on their lines west of Chicago. At this point there were four tracks handling an aggregate of 150 trains per day. This complication of tracks is shown by Fig. 1.

Clark St. is a very busy thoroughfare on account of the depots in this vicinity, and is also the only street from the south side upon which trolley wires are permitted clear down into the city, so that the street car traffic amounted to almost a procession of cars. The plans for this work were necessarily intricate, owing to a network of crossings just southwest of this point. Immediately west of and parallel to Clark St. are the tracks of the Lake Shore & Michigan Southern, the New York, Chicago & St. Louis, and the Chicago, Rock Island & Pacific railways, aggregating four main tracks. These were crossed at grade by the tracks of the Chicago & Western Indiana and Atchison, Topeka & Santa Fe first mentioned; also by the Air Line and Chicago, Madison & Northern railways. The Air Line also crossed the Chicago & Western Indiana and Santa Fe. With the connecting tracks of these various roads there were, within an area of about three acres, 113 crossings. With a long freight train passing on the Air Line it was not unusual at the beginning of this work to see 12 or 14 trains waiting on the other tracks for a crossing, and to see street cars lined up on Clark St. for two blocks each way.

Plan.—The plan as carried out was as follows: The C. & W. I. and Santa Fe tracks were separated from all the others by depressing them about 8 ft. at the crossings, and by raising the Lake Shore and Rock Island, the Air Line and the C. M. & N. about 10 ft. above their original level. The Air Line was shifted south about 85 ft. at its crossing with Clark St. Clark St. was carried down on a 2% grade, going north from 16th St. and passing under the Air Line, then up on about a 5% grade to a viaduct over the Santa Fe & C. & W. I., and from there down again on a 4½% grade, reaching the original surface at 15th St. The total change on Clark St. extending only 700 ft. The depression of the C. & W. I. and Santa Fe, with tracks crossing at so many places, made a continuous subway necessary for about 1,000 ft.

*Assistant Engineer Joint Track Elevation, 16th and Clark Sts., Chicago, Ill.

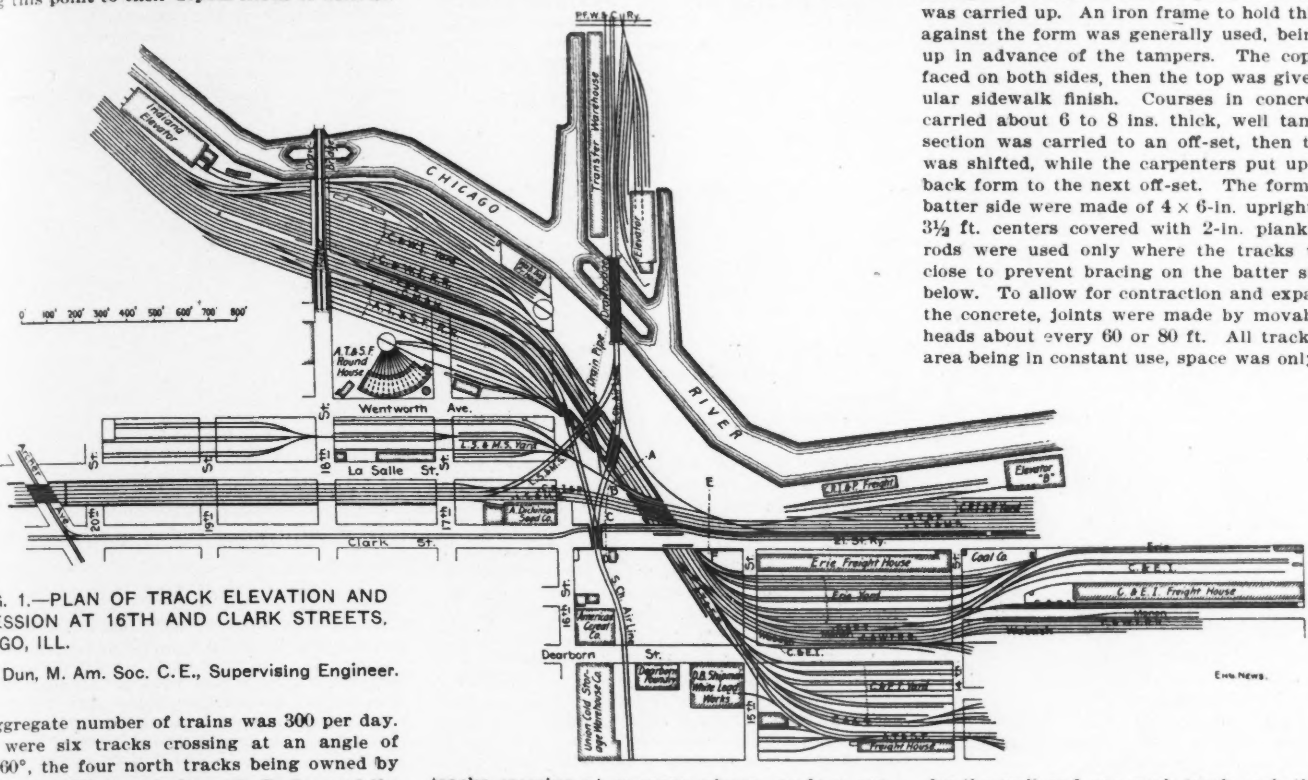


FIG. 1.—PLAN OF TRACK ELEVATION AND DEPRESSION AT 16TH AND CLARK STREETS, CHICAGO, ILL.

James Dun, M. Am. Soc. C. E., Supervising Engineer.

About 400 ft. southwest of Clark St. the two tracks of the Santa Fe leave the C. & W. I., going south to the Santa Fe yards. The area between the two roads starting south from this point is elevated for the C. M. & N., and for a Lake Shore switching track, both passing over the Santa Fe opposite 16th St., and getting back to the original level at 18th St. This area is sustained by retaining walls running out near 18th St.

Construction.—The organization for this work was "The Joint Track Elevation and Depression, 16th and Clark Sts., Chicago." The Chief Engineers of the seven companies concerned constituted an Advisory Board, which selected one of their number, Mr. James Dun, of the Atchison, Topeka & Santa Fe Ry. for Supervising Engineer. Major G. W. Vaughn, of Leavenworth, Kansas, was appointed Engineer in Charge, who, with an Engineering and Accounting Department located at the work, handled it throughout. Mr. E. H. Lee, of Chicago, was Principal Assistant Engineer until his appointment as Engineer of the C. & W. I. R. R., in December, 1898.

Work began in the latter part of March, 1898. Concrete had been decided upon for the abutments and retaining walls, and a contract was let to the Brownell Improvement Co., of Chicago, for furnishing cement, sand and stone, and for foundation excavation, and placing the concrete. All work on the tracks was done by forces of the Joint Track organization before mentioned. Space was cleared for the north wall of the C. & W. I. first. The first concrete was laid the latter part of April, 1898. The sections adopted are shown by Fig. 2. The footing was composed of Louisville cement 1 part, sand 2 parts, broken stone 4 parts, the balance of section being Portland cement 1 part, sand 2½ parts, broken stone 5 parts. The total concrete in walls, abutments and pedestals was 16,800 cu. yds., of which there were footings (Louisville cement), 4,860 cu. yds.; neatwork and coping (Portland cement), 11,940 cu. yds. The materials in 1 cubic yard of concrete were as follows:

Footings.		Neatwork and Coping.	
Louisville cem.	1.51 bbls.	Portland cem.	1.47 bbls.
Sand	0.39 cu. yds.	Sand	0.415 cu. yds.
Broken stone	0.81 " "	Broken stone	0.764 " "

The large proportion of Portland cement was due to facing on batter side of section, and finish on three sides of coping. All cement was thoroughly tested before acceptance. Against the batter form, which was of dressed lumber, a ½-in. facing of Portland cement 1 part, sand 2½ parts, was carried up. An iron frame to hold this facing against the form was generally used, being taken up in advance of the tampers. The coping was faced on both sides, then the top was given a regular sidewalk finish. Courses in concrete were carried about 6 to 8 ins. thick, well tamped. A section was carried to an off-set, then the force was shifted, while the carpenters put up another back form to the next off-set. The forms on the batter side were made of 4 x 6-in. uprights, about 3½ ft. centers covered with 2-in. planking. Tie rods were used only where the tracks were too close to prevent bracing on the batter side from below. To allow for contraction and expansion of the concrete, joints were made by movable bulkheads about every 60 or 80 ft. All tracks in this area being in constant use, space was only cleared for the wall and one work track each time. The contractors mounted a concrete mixer with portable engine, etc., on a flat car. Cars of material were stood in the rear of this from which the aggregates were wheeled to the mixer, which dropped it into the wheelbarrows underneath, whence it was wheeled directly into the walls. There were two of these mixers in constant use. The excavation for these walls was carried to about water level of the Chicago River (City Datum). Stiff yellow clay was found at this depth, and the footing course was bedded on this.

Elevation of Tracks.—During the time the masonry was going in, the track forces were reducing the number of tracks to the least that traffic could be handled upon. The C. & W. I. had been cut down to two tracks. The Santa Fe to one track entering their yards, the Air Line to one track, the C. M. & N. to one track, and the Lake Shore and Rock Island to three tracks. This put the two tracks of the C. & W. I. and one track of the Santa Fe well over to the south side of the proposed subway. The plan was to elevate all the tracks in service, then arrange to get in some depressed tracks for the C. & W. I. and Santa Fe in the remaining area of the subway, after which their tracks above could be discontinued, leaving the Lake Shore and Rock Island and the C. M. & N. and Air Line in elevation, and finish the depression. This elevation was done with bank sand, 42,500 cu. yds. being used. Train loads were run in during the night, and elevation made by day forces. From the west line of Clark St. to the Air Line and C. M. & N. crossings of the C. & W. I. and Santa Fe, about 400 ft., the tracks were raised 11 ft. above their original level. Three per cent. grades were run off from these points to the original level. This work was completed in 15 days, there having been as high as 500 men working in this area at one time. Train service was continued over these grades, and pile bridges put in under the crossings and out back of the points the obvious defects, but also against those which are for the time being hidden or latent.

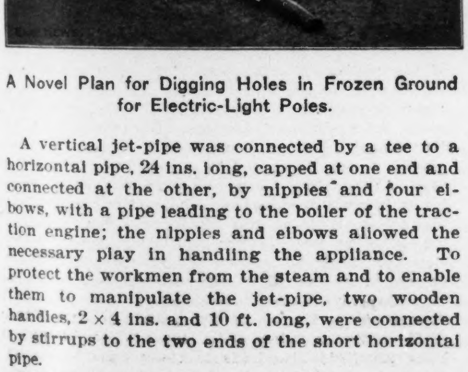
It is generally necessary in securing sufficient capital to carry forward to success any important industrial enterprise based on patents, that the investors should continue as they have generally done heretofore, to make their investment, to "bet," if this term be preferred, on the faith which they see their experienced acquaintance or associate actually has in the enterprise that is offered for their consideration. It is a fact too well established even to warrant discussion that investors as a class rarely make investments in such enterprises because of any favorable judgment which they may form from a personal investigation of the real merits of the business. Many years of contact with that class of people confirms me in the views here expressed, which are also supported by the experience of others who have had an extended acquaintance in the same line of industrial work.

Of course it is true that in some cases the character and scope of the patent, even when these were known, have been either ignorantly or wilfully misrepresented. In this, as in other lines of business, the representations and the goods do not always correspond. Nevertheless patent property has become enormous in volume, and the interests involved compare favorably in extent and value with those of almost any other class or kind of property. It is, therefore, of the greatest moment that the relations existing between patents and the business carried on hereunder should be more accurately and more generally understood; that the risks and uncertainties, the scope and limitations of the protection should be clearly apprehended. The royal road to success, so far as there is one, seems clearly to lie in the direction of supplementing one patent by another and thereby cementing together into one homogeneous mass a complete system or network of protection which considered as a whole will be, during the life of the patent, substantially proof against serious attack, notwithstanding that no patent in the system may be even fairly strong when taken by itself.

Through the methods here outlined an enterprise of this class based upon any really marked advance in a useful art, can generally be made sufficiently attractive to capital to induce the investment of a sufficient amount to insure commercial success. By thus consolidating into one system many related units of protection a sufficiently broad and sound basis can usually be built up to warrant the employment of enough capital to bring the benefits of the improvement to the general public in a relatively short time.

PLANTING ELECTRIC LIGHT POLES IN FROZEN GROUND

In the city of Decatur, Mich., Mr. James W. Pearl, who had the contract for planting electric light poles, resorted to an ingenious expedient for making the necessary holes in deeply frozen ground. The frost effect extended down about 4 ft. and dynamite was tried with unsatisfactory results. Mr. Pearl then devised the following method of thawing the ground by steam furnished by the boiler of an ordinary traction engine:



A Novel Plan for Digging Holes in Frozen Ground for Electric-Light Poles.

A vertical jet-pipe was connected by a tee to a horizontal pipe, 24 ins. long, capped at one end and connected at the other, by nipples and four elbows, with a pipe leading to the boiler of the traction engine; the nipples and elbows allowed the necessary play in handling the appliance. To protect the workmen from the steam and to enable them to manipulate the jet-pipe, two wooden handles, 2 × 4 ins. and 10 ft. long, were connected by stirrups to the two ends of the short horizontal pipe.

This jet-pipe was forced down by two men pressing on the handles; as the earth thawed out, the steam would carry the particles out alongside the pipe; and as the depth increased more steam would be condensed in the bore-hole until finally no steam escaped and the outflow was liquid mud. This outfit would thaw out about 30 holes for electric light poles in a day of ten hours.

Mr. Pearl says that while a large percentage of all the water service pipes throughout the town were frozen, though laid at a depth of 4 to 5 ft. below the surface, the really hard frozen ground was seldom over 30 ins. deep, and generally only 24 ins. deep. Below this depth the earth seemed to lack the moisture necessary to make it very hard when frozen. We are indebted to Mr. Pearl for the photograph herewith reproduced, showing the apparatus above described in operation.

NEW FRENCH LAW REGULATING THE USE OF WATER.

Until recently France has had no laws systematically regulating the use of water derived from rainfall, springs or streams. This omission has been made good by the promulgation of the law of Aug. 8, 1898, which has for its object: (1). The regulation of the ownership and the regimen of rain water, spring water, and all classes of flowing streams. (2). To determine the rights and obligations of individuals and communities, departments and the State, in all questions relating to the flow of water.

Rain and Spring Water.—According to this new law, every owner of the land has the right to use and to dispose of the rain water which falls upon his territory; and the same right applies to all spring water naturally rising to the surface, or which may be brought to the surface by boring or other subterranean work. The owners of lands lower in elevation are obliged to receive these waters; but they reserve to themselves the right to an indemnity for damages done, according to circumstances. The right of free use of such water was not contested in the old law; but the law of 1898 introduces certain regulations for the control of rain water that the Civil Code omitted. The most important of these is one relating to the ownership of both rain and spring water. There is always a difficulty in reconciling the rights of the owner of the land upon which the water has its source with those of the owner of lower land. The latter may utilize the water coming to him either for industrial purposes or for irrigation; but the question is whether he thus acquires a right of ownership in this water course; or whether this right rests upon the discretion of the owner of the higher land? In other words, can the upper owner, either from caprice or interest, use up or turn aside water indispensable to the existence of industrial or agricultural establishments, located down stream and on other land?

The Civil Code does not answer this question, and the French Cour de Cassation has always ruled in favor of the absolute right of the owner of the source of the water. Against this right, according to the ruling of the Court, nothing could prevail except a positive title, or the 30-year limitation clause. But these exceptions only ran from the day when the owner of the lower land made and finished upon the upper lands where the water had its source, works evidently intended to facilitate the course and fall of water into his own property. This ruling resulted in grave consequences; among others, the unquestioned right of the owner of the source to sell this water, without any responsibility, to towns or individuals desiring to use it; no matter what damage might follow to the owners of land on lower parts of the streams. The new law attempts to solve this problem as follows: It makes a distinction between the simple source, and the more abundant sources of water. The first is considered as the absolute property of the owners of the spring, subject only to positive title or limitation; the second class can in no case be turned from its course to the detriment of owners lower down the stream—"if, at the point of issue the spring water forms a stream which has the character of public and running water." The law provides that the local court shall decide, in each particular case, under which category the source in litigation belongs.

Non-Navigable Water Courses.—This part of the new law does not change the Civil Code, but it defines in more detail the rights of owners of land and streams which are non-navigable, and upon which boats, logs, etc., can not be floated.

Owners of land on such streams can utilize the water running through their property, on condition of conforming to the law and to general and especial regulations made by the administration. But they must return this water to its ordinary course at the point of issue from their lands. Falls of water come under this same ruling. The owners of the land also own the bed of such streams; and also all alluvial deposits, islands, etc., which form in the water-course. As a consequence, they have the right to take out of such a stream all the natural products, and to extract the mud, sand or stones; provided only, that the course of the stream is not changed. If the proprietor controls the lands on both banks of the stream, he owns all that is in it; if not, he owns up to a line indicating the middle of the stream.

When such a watercourse abandons its bed through natural causes the owners of the land upon which the new channel is established are held to permit this passage without indemnity. They are permitted, however, within the year that follows the change of route, to take every necessary measure to re-establish the stream in its old channel. The owners of the banks of the old channel are entitled to a similar privilege. The right of indemnity is reserved, however, when the old bed of the stream is enlarged or displaced as the result of public work legally executed; and in this case the former condition of affairs cannot be re-established.

The care and policing of non-navigable streams is incumbent upon the local administrative authorities. The simple use of the water, without special works of appropriation, requires no special authority, as a rule. But no dam, or other work intended to establish a fall of water for a mill or other industrial use, can be erected upon these streams without the formal consent of the authorities; and this permission may always be modified or revoked if the public interest demands it.

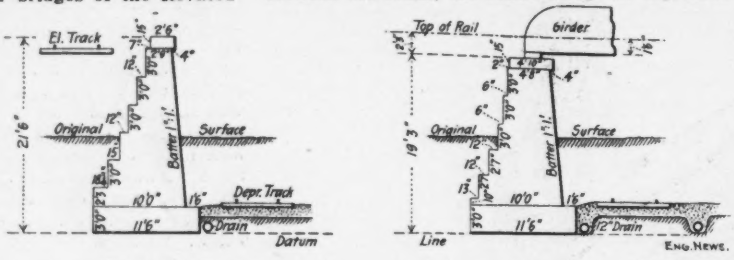
Navigable Streams and Rivers.—Streams and rivers which are navigable for boats, boats in tow, or rafts, are part of the public domain, and are owned by the State, from the point where they commence to be navigable to their mouth. In addition, the following parts of such streams also belong to the public domain. Branches of such streams, even when non-navigable, when they join the stream below the point where it commences to be navigable; the pasture land and drinking places which draw their water from these streams, and all islands naturally formed. Exception is made for the derivation, or artificial channels of water made for the use of individual abutting owners.

Previous to the promulgation of the new law, when a navigable river abandoned its old bed and formed a new channel, the Civil Code declared that the owners of the new land occupied could take, as an indemnity, the old river bed abandoned, each owner in proportion to the land lost by him. The law of 1898 abrogates this Article 563 of the Civil Code, and rules that the proprietors of adjoining land have the right of pre-emption to acquire ownership of this old river bed, each in due proportion to land lost, up to a line drawn down the middle of the stream-bed. This right must be exercised within three months after notification by the Prefect and at a price fixed by experts named by the President of the local tribunal. In default of the exercise of this right by the owners of the old river banks, the old bed becomes part of the State domain, according to the law provided. In either case, the amount derived from the sale is distributed to the owners of the land occupied by the new channel, in proportion to the amount of land taken away.

The owners of land on navigable rivers, in the interests of navigation, are required to submit to the following regulations: (1) On all such rivers, especially where boat-towing is established, abutting owners are required to leave a free space, 25.6 ft. (7.8 m.) wide, along the banks of such rivers, and on islands when necessary. (2) Owners cannot plant trees upon, or enclose by hedges or otherwise, any ground nearer than 32 ft. (9.75 m.) to the river edge on the tow-path side; or nearer than 10.6 ft. (3.25 m.) on the bank opposite the where abutments were yet to be built. The piling was driven down below the grade of final depression.

Depression of Tracks.—In the subway proper there was considerable space north of the C. & W. I. tracks in which the work of depression had been continued. It was now opened through these pile bridges, and tracks soon put in service. As soon as two tracks in depression were put in regular service, the C. & W. I. and Santa Fe tracks above were taken up and a steam shovel turned into the area. Along with the depression, abutments under the Lake Shore and Rock Island and Air Line, now elevated were completed.

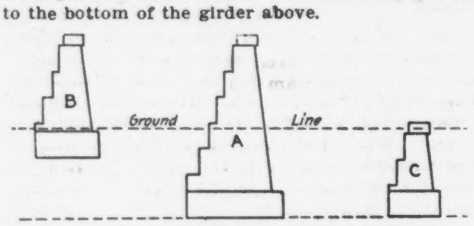
Following the depression, pedestals were put in for the permanent girder bridges of the elevated roads, and for the Clark St. Viaduct. These pedestals were made of Portland cement concrete, with a base generally 8 × 12 ft. Most of the permanent bridging was put in immediately following. The railway companies owning the elevated tracks put in their own permanent bridges. Clark St., which had been closed since May, was now paved and opened for traffic about Nov. 20, 1898.



Retaining Walls. Abutments.

FIG. 2.—TYPICAL SECTIONS FOR RETAINING WALLS AND ABUTMENTS, 16TH AND CLARK STREETS GRADE CROSSING WORK.

The system of drainage put in the subway was 12-in. cast-iron pipes laid between tracks, extending from a cross drain, of two 20-in. and two 24-in. pipes, about midway in the subway, each way to the points where the grades start up to the original level. The pipes were laid with open joints, and the trench back filled with ballast. These cross drains empty into a pump recess built in the north wall. Centrifugal pumps operate here to lift the water over into a closed compartment connected with the river, 250 ft. away, by three 24-in. pipes laid at the water level of the river. The elevation of the top of the rail in the subway is about 3½ ft. above the river. The headroom for depressed tracks is 16.2 ft. from the top of rail to the bottom of the girder above.



Elevation. Wall as Built. Depression.

Fig. 3.—Diagram Illustrating Method of Apportioning Cost of Work Between Different Companies.

The settlement of abutments and walls has been considerable. The temporary elevation and then driving piles along the toe for temporary bridges caused the greatest amount. The south wall opposite the center of the subway—at the Air Line Crossing—settled during this time about 6 ins., running out to about 3 ins. at Clark St., and the same south. Since that time the settlement has been general, amounting to an additional 3 ins. In the past three months the settlement has been less than 1 in. with the abutments under traffic. The joints left in the walls for contraction and expansion worked to decided advantage during this settlement, and no cracks of importance show outside of these joints. After settlement these joints were neatly trimmed.

Trackwork.—In the permanent location of the passenger tracks a minimum of 13 ft. between centers was observed where curves exceeded 10°. For freight tracks the spacing was 12.5 ft. For passenger service and coach yard connections 15° curves were the maximum, except in one or two instances. For freight traffic 26° curves are in use in some of the yards, and a 25° curve in use in a transfer track. The gage was widened 1 in. on these heaviest curves, and the trains soon cut out more, so that 1¼-in. would not be excessive. It was found that about 17° curves were as heavy as passenger trains would operate on, unless cars were coupled out, especially the sleeping-cars. The completion of trackwork leaves the depressed tracks free from crossings, except eight slip switches in use for their own service. The elevated tracks, with all connections, have an aggregate of 32 rigid crossings and two slip switches in the area in which there were originally 106 crossings. Rock ballast was used in all tracks and yards on final location.

Apportionment of Cost.—The division of cost for the Joint Track forces was kept by a daily report from the General Foreman's office to the Accounting Department. For the contract work the Engineers' Records were used. By an agreement between the roads, the roads using the depressed tracks were to pay for the abutments for elevated structures, while the roads using the elevated tracks furnished and erected their own permanent bridging. For the division of retaining walls the following from the Official Records is quoted, the references being made to Fig. 3:

Section A is the section of constructed wall whose area, multiplied by length, gives total quantities. Ground line is the elevation of original surface on line of wall. Section B is theoretical section of wall for track in elevation from ground line using the same dimensions from top down, as Section A. Section C is the theoretical section for track in depression from ground line, dimensions as above. The division of A Section, or quantities, is made according to the ratio of B and C; that is, B + C : A :: B : x, and B + C : A :: C : y;

or, $A \times \frac{B}{B+C} = x$, or B's portion, and $A \times \frac{C}{B+C}$ $= y$, or C's portion.

Coping section for B and C is the same as A; hence coping quantities are charged one-half to B, one-half to C.

Neatwork being a different class of concrete from footing, is divided independently. The B portion was charged to the elevated roads adjoining the wall. The C portion to the depressed tracks next the wall. By agreement the Clark St. viaduct was charged to the depressed roads, the pavement in the same way, except a portion to the Air Line and C. M. & N. at their crossing of Clark St. The total cost of the work, which can be charged to new construction, is about $500,000. This does not include any work on the Air Line east of Clark St., as the Illinois Central did this work independently of the Joint Track Elevation and Depression, and only includes the work on the Lake Shore and Rock Island tracks, from 15th St. to 16th St.

During the progress of the work railway traffic was continued over this area without interruption and with no accidents of any consequence. To maintain traffic was the uppermost idea with all connected with the work, and owing to the extreme precautions taken accidents were avoided. The several companies are now making preparations for interlocking and block signaling at this point, and trains will run over this area without detention. All trains entering the Dearborn Station now pass from 21st St. into the station without a railway crossing. The work is complete at this point at the present time, except the permanent bridges of the Air Line and Chicago, Madison & Northern, which the Illinois Central is constructing their work from the lake front west, and will complete in a short time.

PROPERTY IN PATENTS AND HOW TO PROTECT IT.*

By Francis H. Richards, M. Am. Soc. M. E.

The subject of property in patents, or "patent property," is probably less generally understood than almost any other class of property rights, and necessarily the subject is a many-sided one.

An important fact in connection with nearly all important enterprises which have been built up through the control of patents is that the patents which were at first relied upon for protecting the business were capable of being easily evaded; and that notwithstanding such incompleteness of patent protection, this protection was effectual for its intended purpose. In more recent years, owing doubtless to the increased competition among inventors, such defects and insufficiencies in the patent or patents under which a business may be developing involve a greater commercial risk than formerly. Consequently we need at the present time to more carefully consider the ways and means whereby the defects and insufficiencies of any particular patents or set of patents may in a practical way be cured or supplemented, whereby the property rights may be safeguarded.

It is sometimes remarked, especially by so-called conservative investigators, that while they are at liberty to risk their own investments, they cannot permit themselves to encourage a similar risk on the part of a client or associate. While that view of the matter is in many instances entirely justified, it is often based upon a misapprehension of the conditions which necessarily appertain to the subject. It is an old adage that "Nothing risk, nothing gain." This maximum might well be read: "With no great risk there is no great gain." But the "risk" is a relative matter and not an absolute one. That which in the hands of one party would inevitably fail may in the hands of another be successful. Not infrequently an enterprise which from one view-point has already failed, has in fact merely reached the first toll-gate on the highway of success.

The probability of success is measured by the environment and the resources available. One party, examining a certain enterprise and finding the risk of too hazardous a nature to warrant his attention, may very properly decide the enterprise to be impracticable, or, as to himself, impossible of accomplishment. This decision under the circumstances does not in the least indicate that from the standpoint and experience of some one else the same enterprise cannot be safely undertaken and effectually carried on to a successful conclusion. The real question, therefore, is not so much whether a risk exists, but what relation the existing risks and uncertainties bear to the ways and means that are available for overcoming them.

At the present time it is probable that in a strictly commercial sense the highest kind of "property" consists of public franchises. It also seems to be well established that patent property, under favorable conditions, is a good second, not even excepting real estate. While it is now generally recognized that an invention, and therefore the patent granted for the same, is "property" rather than a franchise, it is nevertheless a conditional property. That is to say, the title to this property is a conditional title and must remain so from the very nature of the case. From these considerations it seems to follow as a necessary consequence that the element of uncertainty, of risk, can never be eliminated from this kind of property.

The method by which successes are wrought out in this domain result not from the elimination of the risk, but rather from the safeguarding of the enterprise against attack. What amounts to a fatally defective feature of one such piece of patent property, when considered by itself, may often be safeguarded by fortifying the approach through which that property may be attacked.

Through the amplification of inventions therefore and by means of successive patents which overlap in subject-matter, as well as in the scope and character of the protection afforded thereby, the defects and risks inherent in particular patents can very frequently be effectually safeguarded. This view of the subject harmonizes very closely, it seems to me, with the almost universal experience of inventors, manufacturers and investors who have dealt extensively with such enterprises.

Among my own acquaintances there are a number who have in the course of time amassed considerable fortunes derived very largely through the exploitation of patents, but in no such case within my experience has the beneficial result accrued entirely from any one patent nor from any one species or grade of patent protection. The results in such cases have uniformly come, first from thoroughgoing protection in each case of so much as could fairly be had in that case, and in then extending around the commercial enterprise the protection of different classes of patents whereby, as I have already stated, the defect or incompleteness of one is safeguarded by another. Experience has shown that only in the rarest cases, if ever at all, is a patent finally interpreted by the court from the particular point of view taken by the inventor, or by his attorney, at the time the patent was granted. We have, therefore, not only to guard against

*From a paper read at the annual meeting of the American Association of Inventors and Manufacturers at Washington, D. C.

There seems to be a general misunderstanding among owners and, in some cases, among architects as to what constitutes the real value of the engineer's services. In all too many cases his work is considered well done if a plant is installed without giving trouble and which accomplishes the desired results in the matter of lighting, heating, power, etc. These results must, of course, be accomplished in any case, but the true value of the engineer lies in accomplishing the results in such a way that the annual operating expenses and the fixed charges on the building equipment will be a minimum.

The importance of this is in many cases not realized, and the plant is designed without giving the matter any serious consideration. As a matter of fact, the yearly operating expenses and fixed charges on the mechanical equipment of a modern building are likely to be from 20 to 40% of the cost of installing the plant, and in a large building or group of buildings will be anywhere from $20,000 to $100,000, or even more, per year. A poorly-designed plant may give results which are apparently satisfactory, but these results will be obtained at a needless expense to the owner of, perhaps, thousands of dollars per year. I have had occasion myself within the last few weeks to examine two plants where this was actually the case. In one the extra cost caused by mistaken design amounted to about $1,500 per year, and in the other to about $3,000 per year, and in both cases the loss could easily have been avoided without increasing the first cost of the plant.

The best results in general operation and in economy can, however, never be obtained by having each of the different parts of the equipment well designed. The electric lighting plant and the heating plant may each be a model of economy and satisfactory operation when considered by itself, but they may at the same time be entirely unsuited to each other and uneconomical when operated together. The different parts of the building equipment are so mutually related that one cannot he properly decided on without considering all of the others. The same steam that drives the lighting plant and the elevator pumps should be used to heat the building and to heat water for the plumbing system; the number of lights and the hours which they are burned must be considered in deciding whether it is best to use motors or engines to drive the ventilating fans. The type of elevator which it will be most economical to use depends partly upon the size and load of the electric lighting plant and on the amount of steam which will be required for heating the building. The type of engine to be used will be influenced by the requirements of the heating system and the elevator service. The type and size of boilers required will depend on the type and requirements of the lighting, power and heating apparatus. The plan, therefore, which I have recommended—of having a single engineer or engineering firm take charge of the entire equipment—is the ideal method of looking after the work, and is the one which will undoubtedly be finally adopted.

There is one branch of engineering service in connection with building work which is entirely outside of those already mentioned, but which should, in a certain sense, be considered with them. This is the employment of experts to calculate and design the steel work and especially the steel frames of large buildings. Up to the middle of the present century the principal building materials were brick, stone and wood. There had been very few reliable and accurate tests made to determine the strength of these materials, and such tests as there were showed a wide range of results, with different samples and under different conditions. The architect and builder had, therefore, to allow a very large margin for safety in every case, and the amount and size of materials to be used were determined more often by precedent than by calculation.

When scientific study and invention developed the steel and iron industry it practically placed a new material in the architect's hands—a material, moreover, which was uniform in character, and which could be relied upon to have almost exactly the same strength at all times and under all conditions. As soon as this was generally realized, and the strength had been learned by careful experiments, the architects began to figure their work more exactly, and to put up higher and higher buildings, in which the load was carried largely, if not entirely, by the steel frame. The problem of properly designing this frame so as to obtain the required strength with a minimum quantity of material is a difficult one, and there is a considerable difference of opinion as to whether its solution is a legitimate part of the architect's work or not. I have myself talked the matter over with a number of architects without coming to any very definite conclusion, and find that opinion seems to be about evenly divided.

On one side it is claimed that architecture includes and has always included a knowledge of all methods of construction and of the principles of applied mechanics. The architect has always been expected to be well informed on the strength of materials, in order that he might design his building properly for the load which it was to carry. There is, therefore, no reason why he should not to-day be expected to be thoroughly familiar with all forms of steel construction, and be able to properly design and calculate the work.

This is generally admitted by those who take the opposite view, but it is argued that an architect who designs only one steel frame in perhaps several years cannot possibly solve the problem as well as the engineer of a steel company or an expert who gives his whole time to this kind of work, and that the owner would in nearly all cases save money in the end if he were to pay a slight amount extra to have the frame designed by such an expert.

I shall not attempt to discuss the question in detail, because it is not strictly within the limit of the subject which I am considering to-night. I have mentioned it because the two matters are very closely connected, and in the hope that some new ideas and opinions may be brought in the discussion which is to follow.

I have now considered in a general way the relation of the architect and engineer to each other, and to the building equipment, and shall take up next the question of commission: first, the amount which the engineer should receive for his services, and, second, the amount which the architect should receive on the building equipment and the manner in which both should be paid. The first question can, I think, be easily answered. The work which the engineer is required to perform in relation to the building equipment is almost exactly the same as that which is expected of the architect in relation to the building itself. He should, therefore, make his charge on the same basis as the architect, and should adopt the Schedule of Minimum Charges which has been prepared by the American Institute; that is, he should receive not less than 5% on work costing over $10,000, and should receive a reasonable amount in excess of this on work of less than $10,000 value and upon alterations of old work.

This seems to be clear and beyond dispute in any way, and we can, therefore, turn to the second question, or the amount which the architect should receive on the building equipment and the manner in which he and the engineer should be paid. I have already shown that there are many reasons why the engineer should be engaged by the architect, and should be responsible to him in all of the work. It, therefore, follows naturally that he should in all cases be paid by the architect, either out of the architect's own commission or out of an additional commission which the architect should receive from the owner. Now, if the architect receives only 5% on the building equipment, he must pay all of this to the engineer, or, if the equipment costs less than $10,000, he must actually pay more to the engineer than he receives himself. At the same time he is held responsible by the owner for the selection of a competent engineer and, in a general way, for the work which the engineer designs; he must furnish the engineer with all necessary information with reference to the details of the building and its requirements, must study the engineer's plans and assure himself that the equipment conforms properly to the building as a whole, and, finally, must make a very large number of changes in the details of the building construction to allow for the proper installation of the flues, pipes, wires and machinery.

These changes make very little difference in the final cost of the building, and, therefore, do not increase the architect's commission, but they do very materially increase the work which he is required to do. It is evidently absurd to expect the architect to engage an engineer under these conditions, and it is clear that he must either receive an additional amount to cover the cost of the engineer's services or he must give up the engineer entirely and look after the work in some different manner.

There is, I find, some difference of opinion as to the amount of commission which the architect should receive in addition to the cost of the engineer's services, but the majority of the architects with whom I have talked have agreed that the full 5% is none too much for the work which he is required to do. It is, of course, impossible to obtain any accurate estimate of the expenses to which the architect will be put in connection with the design and installation of the building equipment. In cases where the entire responsibility and work are thrown on to the engineer, the architect's expense is comparatively small, but it seems to me, that if the architect is to assume the general responsibility and charge of the work, in the manner which I have outlined, he will not make any unreasonable profit if he receives his full 5%.

The charge of 10% on the cost of the building equipment seems excessively large to the owner, and, in most cases, he objects to having an engineer employed under any such conditions. But let us consider for a moment what he has to pay if the engineer is not employed. Under these circumstances, the architect in most cases calls in one or more contractors, explains to them the details of the building and its uses, and gives them a general statement of the results which he wishes to accomplish in the matter of lighting, heating, ventilation, etc., and asks them to submit plans and estimates for doing the work.

The contractor draws the necessary plans and brief specifications, and hands in a proposal for doing the work in accordance with these. The owner thinks that he has avoided the engineer's commission, but, as a matter of fact, he is paying for the engineering work as a part of the contract price.

This fact is sometimes admitted, but it is claimed that the cost of having the plans drawn up in this way is very much less than it would be if they were prepared by an engineer—and, at first sight, this might appear to be the case. The contractor's plans and specifications are usually not as complete as the engineer's, and he is not, of course, expected to make any inspection of the work during construction. The amount of work which he does is, therefore, less, and his charge should be decreased in proportion. On looking into the matter more carefully, however, the saving will be found to be largely imaginary. It is true that the contractor does less work than the engineer in planning the equipment for a building, but when this part of the work is placed in the contractor's hands it is very often duplicated by having several sets of plans drawn for the same building by different contractors. In this way a large amount of unnecessary work is performed which must be paid for by the owners of the buildings. The contractor must add to each proposal a percentage amount sufficient to cover the average cost of the engineering services. I am informed by one of the leading steam contractors of Boston that the actual outlay for engineering work in his office—the drawing of plans, specifications, etc.—averages each year nearly 5% on the total of his contract work. The increased office expenses have been so great in some cases that the contractors have entirely given up their engineering department, having refused to draw plans and specifications, and have in this way tried to obtain an advantage over their competitors by being able to underbid them and make the same net profits.

It is clear, therefore, that the owner is deceiving himself when he attempts to save expense by refusing to have an engineer employed, because, whichever way the work is done, he must pay practically the same amount for the design of the building equipment. He must either pay 5% to the architect and approximately 5% to the contractor, or he must pay 10% to the architect; five for his own services and five for those of the engineer.

I have talked with many architects with reference to the matter, and have found them very strongly in favor of taking some action of this kind. I have also talked with them in relation to the form of statement which they advise, and submit the following for your consideration and discussion:—

Change the Schedule of Minimum Charges by striking out the first paragraph, which reads—

"For full professional services (including supervision) 5% on the cost of the work," and substituting for it the following:—

For full professional services (including supervision) when no additional expert services are required, 5% on the cost of the work.

For full professional services (including supervision) when experts or engineers are employed by the architect to design and supervise the installation of certain parts of the work, 5% on the total cost of the work, and an additional charge to cover the cost of the engineer's services.

Discussion.

President Geo. B. Post—I have a much higher opinion of the duties and necessary acquirements of the architect than those expressed in the paper which has been read. Until a few years ago the architects were the engineers of the world. The architect should be equipped with a full knowledge of all building operations. He should know that his plans provide for work safe and strong, and understand all the principles of construction which enter into the whole work of his building. The architect must be the boss, and the engineer should be directly under his control and responsible to him, to carry out his views and elaborate and detail his form of construction. The architect must understand the thing himself, and he able to do it himself, otherwise it will not be possible for him to direct the work.

A good deal has been said about expenses, and a few facts may be of value. During a good many years I have done a reasonably large business, and have had six or eight million dollars' worth of construction going on in my office at a time, but there has not been a square inch of work that I have not been thoroughly familiar with. During that time I have kept an accurate book account of every piece of work. I have received the commissions prescribed by the American Institute of Architects, and if there was elaborate decorative work or cabinet work, 10% on the cost of the decorative or cabinet work. I have myself paid the expenses of all experts I saw fit to employ, and my profits have always been almost exactly one-half of my receipts.

Mr. W. L. B. Jenney.—I agree with Mr. Post that it is absolutely impracticable for an engineer to be employed to do one part of the work and the architect to assume the general responsibility of the whole. It certainly belongs to the architect to arrange for the placing of the columns, for the position of the girders and the floor beams, and all the items of general detail must be done by the architect himself. He has his own able assistants and his engineers, and to them he trusts the calculation of these beams and the girders, and the sections of the columns. There is one part, however, that is the electrical work, which is going ahead with such rapid strides that it is difficult for an architect to keep pace with it, and he is obliged to call in special expert assistants to look over or prepare specifications, to see that everything is properly arranged before it is put out for bids, and to superintend the work and see that it is done exactly as provided in the specification. I think in these large buildings costing seven or eight hundred thousand dollars, there should be sufficient compensation to enable the architect to employ such expert assistance as may be needed.

tow-path. (3) It is forbidden to extract, without special authority, any earth, sand or other material, at a point nearer to the river bank than 38.4 ft. (11.70 m.). (4) As the care of the streams on the public domain is a charge upon the State, all users of water and the owners of land on these streams are warned that any exceptional consumption considerably increases the expense.

THE EMPLOYMENT OF ELECTRICAL, HEATING AND SANITARY ENGINEERS IN BUILDING CONSTRUCTION.*

By H. S. Bradlee, Boston, Mass.

The practice of architecture has undergone a gradual, but very decided, change during the past fifty years, a change which has been so gradual that its magnitude and importance are hardly appreciated.

On the one hand, the range of building materials which the architect has at his disposal has been greatly increased. New processes in the manufacture of iron and steel, of terra cotta and brick, of cement and plaster, have made new forms of construction possible, and have produced the modern steel-frame fireproof building which has now become so familiar. On the other hand, the architect's work is not confined to the design of a building which is architecturally beautiful, which is well and substantially constructed, and which is carefully planned; he must go farther, and equip the building with a complicated system of mechanical anl electrical apparatus. He must design and provide for a network of pipes, flues and wires running through all parts of the building; he must install high-pressure boilers, steam engines, dynamos, elevator-pumps, tanks and machines, electric motors, ventilating fans, refrigerating plants and mechanical kitchen and laundry apparatus. To show how recently this change has occurred, it is only necessary to state that fifty years ago the steam engine had not come into general use, and there was no source of mechanical power which could be used in a building. The heating and ventilation were taken care of largely by open fireplaces and stoves; elevators were not used, the telephone, electric light dynamo and motor were not invented, and the plumbing consisted of a cold-water supply and drain-pipe for two or three sinks, and an out-door privy.

The architect of a modern building, if he is to design it complete in all its details, must therefore be an engineer, and must be familiar with mechanical, electrical and sanitary engineering in all its branches. Each of these departments of engineering has, however, grown to such an extent that a thorough knowledge of its details can only be acquired by years of study and experience, and what is perhaps more important, they are at present in a state of rapid growth. New methods and new appliances are constantly introduced, so that the best work of ten years ago is considered very inferior to-day.

It is therefore clearly impossible for an architect to master all of these subjects and keep himself informed on the new methods which are developed. A man may be a good engineer or a good architect, he cannot very well be both. In fact, the particular traits of character which are necessary in an architect are different from those required by the engineer. Architecture has been defined as "the art of building beautifully."

Engineering, on the contrary, might be defined as the science of building economically, of getting the most strength, durability and use for a given expenditure. The guiding principle of the engineer is economy of operation, and on most of the work which he designs beauty is not even considered.

A few architects may be found who are, by nature, interested in engineering work, and who plan all of the details themselves, but these are very rare, and, in most cases, the entire engineering work is turned over to some one else to look after. There are three general methods by which this may be done:

1. The plans and specifications may be drawn by the contractor who is to do the work, or who is to figure on it in competition with others.

2. A consulting engineer may be called in to draw the plans and specifications and supervise the installation of the work.

3. If the architect has a very large volume of business, he may have a man regularly employed in his own office to take this part of the work in charge. This last method we need not consider, however, as there are very few cases to which it is applicable.

The employment of the contractor to design the engineering work was the first method adopted, and, up to perhaps twenty years ago, was almost universally employed. Gradually, however, as the work increased in scope and in importance it was found that there were some decided disadvantages in looking after it in this way, and the employment of the consulting engineer became more common. I do not need to discuss in detail the advantages or disadvantages of the consulting engineer. It is sufficient to say that the causes which in the past separated the architect from the builder are now at work separating the engineer from the engineering contractor.

To those who are familiar with the situation it seems evident that sooner or later the engineer is to be in some manner as generally employed in connection with the building equipment as the architect is to-day in connection with the building design. The method of employment of the engineer, the work which he is to be called upon to do, and his position with relation to the architect and the owner are matters which custom has not yet defined, and they are at present very far from clear. In one case that came to my attention the engineer was engaged by the architect, and the contractor was told to add 5% to his proposal to cover the engineer's commission. This latter method is, of course, not to be considered, but the question of whether the engineer should be engaged by the owner or by the architect is important. The answer, I think, depends to a large extent upon the position which the engineer is to hold with relation to the architect. If the engineer is to be absolutely independent, if he alone is to be responsible for the entire planning and installation of the engineering work, if the architect is to give no time and thought to the matter and is to have no authority in regard to it, then the engineer should be engaged by the owner, without reference to the architect in any way.

If, on the other hand, the architect is to be held responsible for the building as a whole, and the engineer is to be considered as his assistant on certain parts of the work, and is to work in conjunction with him at all times, then the question assumes quite a different aspect, and it is advisable that the engineer should be engaged by the architect and not by the owner. It certainly does not need any proof to show that a building must be designed as a unit in order to obtain the best results. The architect and engineer cannot go ahead independently on their respective parts. They must work together and must see that their plans conform to each other in all respects. It is, however, very difficult to carry this out successfully if they are to have equal authority with regard to different parts of the work. It is human nature for each to think his own part the more important, and when they conflict in any way to claim that the other should be the one to give way and alter his plans.

The engineer is responsible for the design of the building equipment and for the results obtained from its operation, and he should, therefore, be given every reasonable opportunity to design the work in the manner which he considers best. At the same time, he should remember that the equipment is in all cases subordinate to the building itself, and that in most cases it is easier and cheaper to make changes in the engineering work than in the construction of the building. He should, therefore, be under the direction of the architect, and should make any changes which the architect may wish, provided the changes will not interfere with the success of his own work. If the architect is responsible for the building as a whole, it will be as important to him as to the engineer to see that the equipment gives satisfactory results, and, consequently, be will not require any unreasonable changes and will see that the engineer has, as far as is possible, a free opportunity to carry out his own ideas.

It is not enough, however, for the engineer and architect to work together and see that their plans conform with one another's in a general way; either one or the other should be directly responsible for this; and it seems to me that this responsibility should in every case rest with the architect. The architect is necessarily more familiar with the uses to which the building is to be put and the details of its construction than the engineer can ever become, and he will therefore notice discrepancies which the engineer might easily overlook, and which, if not corrected before the work is started, might cause serious delays and expensive changes. The engineer must do everything in his power to see that his plans can be properly carried out in connection with the other parts of the building work, but the architect should look the plans over carefully and assure himself that this is actually the case.

Now, if the engineer is engaged directly by the owner, and especially if the architect receives no commission on the building equipment, the above conditions cannot be properly met. The architect will naturally feel that this matter has been entirely taken out of his hands, and will go ahead with his plans, with hardly a thought of the engineering work, and will leave the engineer to get it in as best he may. The engineer, on the other hand, will feel far more independent of the architect, will pay less attention to the architect's plans, and will trust to having the details of the architect's work changed later, if necessary, so as to allow his own to be installed. Again, in order to have everything run smoothly and to the best advantage, the engineer and architect should have worked together sufficiently to be familiar with each other's methods—and this is very likely not to be the case if the engineer is selected by the owner; in fact, the owner may select an engineer in whom the architect has no confidence or with whom he does not wish to work for some purely personal reason. It is, therefore, very desirable for many reasons that the engineer should be selected and employed by the architect, and not by the owner, although, naturally, the architect would, as a matter of courtesy, consult with the owner, and would not select an engineer who would, for any reason, be objectionable.

The engineer having been engaged, the work which he is expected to do in the preparation of plans and specifications is generally clearly understood.

The architect is to furnish him with all of the information which he needs with reference to the details of the building, the uses to which it is to be put, and in a general way the results which it is desired to attain in the matter of heating, lighting, ventilating, power, etc. The engineer copies the architect's plans, draws on them the general arrangement of his own work, and makes all necessary drawings of the details of construction. He prepares complete specifications for the work, obtains estimates from a proper number of contractors, and confers with the architect and owner as to which proposal it is most advisable to accept.

The architect, since he assumes the engineer as his assistant, is now responsible for the general agreement of the engineer's plans with his own; but the engineer should not, on this account, proceed without regard to the details of the building construction, leaving the architect to straighten out the discrepancies. Neither should the engineer wait to receive details and general information from the architect; he should follow the matter up himself, and see that he has all of the information which he needs, should make himself as familiar as posible with the architect's plans, and so arrange his work that there will be a minimum number of changes required in the building construction.

As soon as the contracts are let and the building started the question of inspection comes up, and on this there is a wide diversity of opinion. In some cases the engineer is expected to have a man on the ground the greater part of the time, and in other cases all that is considered necessary is an occasional inspection to see that the work is going ahead properly. On large buildings a great deal of confusion and misunderstanding often arises because one set of men is being directed by the engineer and another set by the architect or by the clerk of the works.

Each is trying to push his own part of the work ahead as rapidly as possible, and neither knows exactly how the other's work stands. This necessarily causes interference and delays, which would be avoided if one man had charge of the entire work. The inspection is usually, I think, the most unsatisfactory part of the engineer's services; at the same time, it is a very important part, and for that reason should, if possible, be put upon a better basis.

First of all, it seems to me important that the clerk of the works should have general charge of all of the contractors and of all parts of the work. He should be as well acquainted with the engineer's plans as with the architect's, should see that the work is carried forward in such sequence and at such times that one contractor will not interfere with or delay another unnecessarily, should see that the contractors have a sufficient amount of material and number of men on hand so as not to cause delay, and should keep a general oversight of the work and report to the architect and to the engineer if he finds that any changes in details are necessary, or if he notices any points in which the plans and specifications are not being properly carried out. In other words, he should be the engineer's representative at the building as well as the architect's. I believe that general experience has shown that this method of managing the work is far more satisfactory for all parties concerned than the more common method of leaving a part of the work entirely in the hands of the engineer.

On smaller work, where a clerk of the works is not employed, there are two methods in which the engineer's inspection may be taken up: 1, he may take entire charge of the installation of the work which he has designed, giving personally all necessary directions to the men at work at the building; or, 2, the general direction of all parts of the work may be left to the architect, and the engineer may visit the work from time to time and report to the architect on any part which is not being properly installed. Either of these methods should give satisfactory results, and the one to be adopted in a particular case would depend largely upon the local conditions and the personal wishes of the architect.

In what I have said so far, I have assumed that all parts of the mechanical equipment of a building are to be placed in the hands of an engineer, and that a single engineer or engineering firm will take charge of the entire work. As a matter of fact, there are at present only a few engineers who are prepared to do this, and it is the general custom to have different engineers for different parts of the work. This greatly complicates the situation, for it becomes necessary for the architect not only to see that the plans of each engineer conform to his own, but also to see that theirs do not conflict with each other. Moreover, the actual amount of work to be done is considerably increased, since each engineer must be familiar with the plans of each of the others, as well as with those of the architect, and it is practically impossible to avoid conflicting orders and changes while the work is being installed. This leads in many cases to the employment of only one or, at most, two engineers, who take charge of the more important parts of the equipment, and the less important parts are left entirely to the architect.

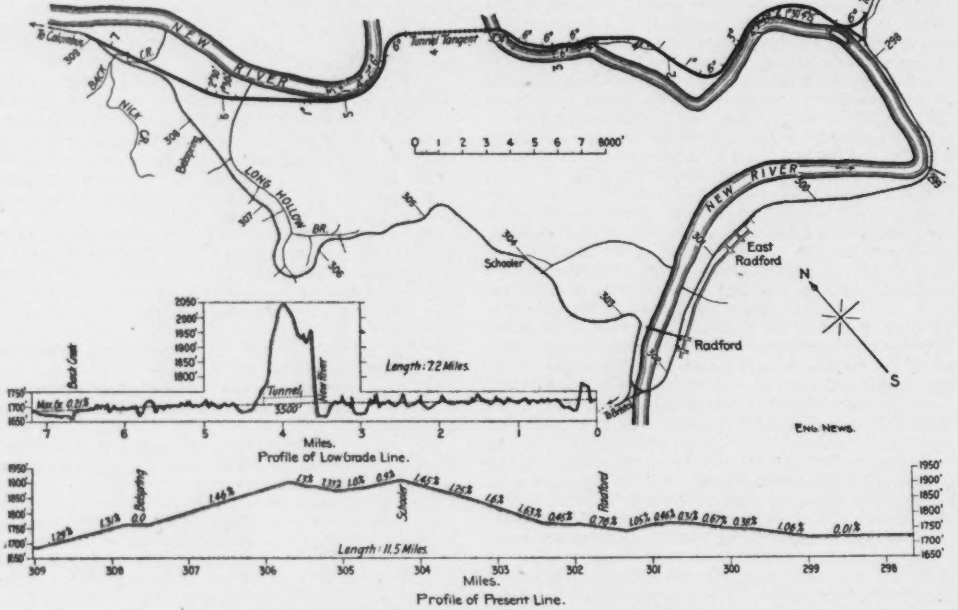
*Condensed from a paper read at the 32d Annual Convention of the American Institute of Architects, and published in the "Proceedings" of the Institute.

IMPROVEMENT OF GRADES ON THE NORFOLK & WESTERN RY., NEAR RADFORD, VA.

A good example of the work which is being done by many railway companies whose lines are now carrying a traffic far heavier than that which was contemplated when they were originally located is shown in the accompanying map and profiles.

As many of our readers are aware, the Norfolk & Western Ry. carries a very heavy coal traffic from the famous Pocahontas field to the seacoast. On the present line a summit over 150 ft. in height has to be crossed just after leaving Radford in the New River Valley, in the western part of Virginia. To avoid this summit, and at the same time considerably reduce the distance, the company has laid out a new low grade line which follows the valley of the New River and passes by a tunnel through one high ridge around which the river bends. The new cut-off, which has been recently placed under contract, will be 7.2 miles long as compared with 11.5 miles by the present line, and the maximim grade is only 0.21%. The tunnel will be about 3,300 ft. long. The contract for all the grading, masonry and tunneling has been let to Walton, Luck & Co., of Falls Mills, Va. The bridge over the New River adjacent to the tunnel will have six spans of 140 ft. each, resting on stone piers, which measure 6 ft. 6 ins. × 30 ft. underneath the coping. The bridge is on a curve of 3° 30′ and will be about 34 ft. above low water. The contract for the bridge superstructure has been let to the Edge Moor Bridge Works, of Wilmington, Del.

It is intended to use the new line chiefly for freight traffic; and the old line will be kept open to reach the branches with which it connects and will be still used for passenger traffic. Mr. Charles S. Churchill, Engineer of Maintenance of Way of the Norfolk & Western Ry. Co., is in charge of the work.



MAP AND PROFILES OF LOW-GRADE CUT-OFF ON THE NORFOLK & WESTERN RY., NEAR RADFORD, VA.

THE BUSINESS OF THE PANAMA R. R. FOR 1898 was seriously affected by the war with Spain, which, during its continuance, caused an almost total suspension of passenger traffic by the steamship line. Despite this fact, and the heavy war risk, the line was continually operated with no more serious interruption than an occasional delayed sailing, and the enviable record was established that this was the sole company with vessels sailing under the American flag which maintained its regular service throughout the war between this country and a foreign port on the Atlantic Ocean. The total gross earnings of the company for the twelve months were $2,142,881, or $157,824 less than in 1897, and the total net earnings were $266,746, or $143,126 less than in 1897. For the railway company the decrease was 10.91%, and for the steamship company it was 7.5%. Continued progress was made during the year in completing the new terminal port and pier at La Boca, in the Bay of Panama, which, as now almost finished, consists of a pier, 1,000 ft. long, 50 ft. wide, constructed on 24 solid cement piers founded on bedrock, shedded its entire length, with five large steam-hoisting cranes and one 15-ton derrick crane, with which to discharge or load three large ships at one time. Basins have been excavated alongside the pier of sufficient size to allow a free movement of vessels of 3,000 tons capacity, and to allow such vessels to be safely berthed there at all stages of a tide which has an average rise and fall of 21 ft. Cargo will be rapidly transferred directly to and from cars on the pier, which is connected by a branch road with the main line. On the pier and mainland adjoining there have been newly constructed and installed an ample train-yard, water-plant for pier and ships, electric light plant, treasure vault, telephone and telegraph lines, track-scale and engine shed, and office buildings.

A MARBLE BLOCK OF OVER 100,000 LBS. was lately taken from the quarry of the Southern Marble Co., in Pickens county, Ga. The block is almost pure white and measures 27 ft. 2 ins. long by 4 ft. 3 ins. square. It is to be used in the construction of a building in one of the Northern States. The next largest block of marble quarried in this state weighed only 45,200 lbs.

A 20-FT. DEPTH AT PORT COLBORNE, the Lake Erie end of the Welland Canal, is being demanded by Montreal shipping firms, so that that port may be on an equality, in that respect, with Buffalo, at the head of the competing Erie Canal. With 20 ft. of water at Port Colborne 7,500-ton lake steamers would be able to unload directly into 2,500-ton steamers which can go direct to Montreal, as soon as the 14-ft. navigation is completed this summer, and there deliver to ocean steamers, with but two transshipments of freight. The merchants of Montreal claim that with these improvements and modern elevators at their city, they can capture a large part of the trade of the Erie Canal.

THE COURSE IN NAVAL ARCHITECTURE, at the Annapolis Naval Academy, is abandoned because of the failure of the last Congress to make the necessary appropriations for carrying it on. The Naval Department now reports that the courses of a similar type, recently founded at some American colleges, are unsatisfactory, or wholly prospective. Until these courses are firmly established, the cadet students in naval architecture will be sent abroad, as was the practice for many years. Two will start in June for the University of Glasgow, and two go to the Ecole Polytechnique, in Paris. The other two of the six students of the Construction Corps will enter the line of the navy.

THE U. S. CRUISERS "Cincinnati" and "Raleigh" are to be extensively overhauled and refitted; the first at New York and the other at the Portsmouth yard. They are to have water-tube boilers of the latest type; the size of the engines will be reduced without lessening the horse-power or speed, and the coal capacity will be increased 130 tons. These changes will require about one year, and the estimated cost is nearly $500,000.

SMOKELESS POWDER CARTRIDGE CONTRACTS were awarded by the War Department on April 4. For the 8,000,000 smokeless powder cartridges for the .45 caliber Springfield rifles, the Union Metallic Cartridge Co., the U. S. Cartridge Co. and the Chester Arms Co. each bid $23.80 per 1,000, and awards were made of 3,000,000, 2,000,000 and 3,000,000, respectively, to these companies. Nearly all the volunteer regiments in the Philippines are armed with the Springfield rifle, and they have so far used black powder, but 3,000 new Krag-Jorgensen rifles have recently been shipped to Gen. Otis, and 5,000 more await his orders at the Benicia Arsenal, in California. Later reports say that, on Jan. 18, 2,000,000 smokeless powder, 45 caliber cartridges were shipped to Manila, along with an equal number of black powder cartridges.

DAY LABOR AT MINNEAPOLIS will be employed to construct certain sewers, hydrants wells and to lay water mains. This plan was adopted a few days ago, when bids for the work named were returned unopened by the city council and the work ordered done by the day, under the direction of the city engineer. At the same meeting of the city council the majority report of the lighting committee recommending the award of a street lighting contract at $1 per 1,000 ft. for gas was rejected. In its place a minority report was adopted providing that the company should be requested to furnish gas for 90 cts., and naming arbitrators to fix the price in case of disagreement.

THE PARIS EXPOSITION OF 1900, including the Champ de Mars, Park of the Art Palaces, in the Champs Elysees, the Trocadero Park and the Esplanade des Invalides and their connections, will cover a total surface of 336 acres along the Seine. The Exposition of 1889 covered 240 acres. Two large buildings will practically occupy the whole of the Esplanade des Invalides, 1,600 ft. long by nearly 1,000 ft. wide; the old Palace of Industry, built for the Exposition of 1855, has been removed, and a Grand Palace of Fine Arts, with a facade 500 ft. long, has been built on the west side of a new avenue leading from the river. On the opposite side of this Avenue Nicholas II. is the Small Palace of Fine Arts. These two buildings are permanent, and will cost $4,200,000. The avenue named crosses the Seine by the new bridge of Alexander III., now being built, and will lead directly to the Hotel des Invalides. The Champ de Mars, 3,280 by 1,640 ft., will be nearly covered with exhibition buildings; and on this area is the old Eiffel tower, and across the Bridge of Jena is the Park and Palace of the Trocadero, the latter used as an art gallery in the Exposition of 1878. In the 1½ miles between the Invalides and the Champ de Mars the banks of the Seine will be lined with special and ornate buildings and exhibits.

PLATINUM has been found in the black sand in the Yukon district, says Consul McCook, of Dawson City. This black sand is found in great quantities, and an analysis by Dr. Willis E. Everette showed that at least 25% of this black sand was not magnetic iron oxide and the two kinds were easily separated by magnets. The test made showed that in one ton of the non-magnetic black sand there was $102 in gold, 96 ozs. of platinum, worth $8 per ounce, some iridium and a trace of tin. The total value of the ton of black sand of non-magnetic quality was thus $870. In some places there are 12 lbs. of black sand to 1½ cu. yds. of bar gravel, with 3 lbs. of non-magnetic sand; and 1,000 cu. yds. of this gravel would give one ton of the selected sand, or a value of 87 cts. per cubic yard outside of any placer gold obtained.

SURVEYS IN ALASKA are to be continued this summer by two parties of the U. S. Geological Survey. One, under W. G. Peters and Alfred Brooks, will locate the sources of the Copper, Tanana and Babesna rivers. The other, under F. C. Schrader, will explore the principal waters of the Koyukuk, an almost unknown region within the Arctic Circle.

THE ANTARCTIC EXPEDITION, which sailed from Antwerp in the "Belgica," in August, 1897, has been heard from. The "Belgica" was commanded by Lieut. Gerlache, and the ship was last previously heard from at Cape Horn on Dec. 30, 1897. Her destination was then Cape Adair, Victoria Land, and she was to return to some Australian port after landing her party. Dr. Cook, of Brooklyn, Long Island, who was one of the Belgian party and had previous experience in polar work as the surgeon of one of Lieut. Peary's expeditions, now cables from Montevideo that he has reached that point on his way home. The "Belgica," however, has resumed her explorations, after having wintered in Antarctic regions. Dr. Cook sends little information, other than that the party went to the Weddell Sea, southeast of Cape Horn and in longitude 40° 45′ W., instead of to Victoria Land. They found hitherto unknown land and saw active volcanoes. A second party, under Capt. Borchgrevink, and sailing from England in 1898, landed at Cape Adair, about Feb. 1, 1899; and two parties must now be actively engaged in Antarctic research, though widely separated.