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TABLE OF CONTENTS.

ENGINEERING NEWS OF THE WEEK 33, 38, 25, 46

TECHNICAL ARTICLES:

The Late Japanese Earthquake (*illustrated*)..... 26
York Road Tunnel of the B. & O. R. R (*with inset*)..... 26
Earthen vs. Masonry Dams, concluded..... 28
Proposed Bridge Legislation..... 29
Steel Skeleton Type of High Buildings (*illustrated*)..... 29
The Survey of Roanoke, Va. (*illustrated*)..... 30
A New Refrigerating Apparatus (*illustrated*)..... 31
Loading Long Girders on Cars (*illustrated*)..... 32
Mild Steels for Structural Purposes, II. (*illustrated*)..... 42
The Ramsey Coal Distributer (*illustrated*)..... 44
Ship Transportation and the Chignecto Ship Railway..... 44
The Hinson-Miller Interchangeable Car-Coupling (*illustrated*)..... 45
Working Narrow Gage Railways with Light Traffic in New Zealand..... 45
Plaster Boards for Fire Proof Construction..... 45
Two-Cylinder Compound Tank Locomotive..... 46

PERSONALS, NEW PUBLICATIONS, SOCIETY PROCEEDINGS..... 33, 34, 35

EDITORIAL NOTES..... 36

Index to Vol. XXVII.—Injury to Wrought Iron by Working at a Blue Heat.—Motors for Aeroplanes.—Brooklyn Bridge.—Senator Cullom's Bill for a Standard Car Coupler.—Accident on the N. Y. Elevated Railway.

EDITORIALS..... 36, 37

The Mineral Statistics of 1891.—Franchises of Water-Works Companies.

LETTERS TO THE EDITOR..... 39-42

The Cattleguard Question (*illustrated*).—Plate Girder Proportioning.—Field Books and Transition Curves.—Which is the Northwest Point? (*illustrated*)—Tests of Vitrified Paving Brick.—Automatic Block Signals of N. Y. P. & B. R. R.—The Equities of an Overhead Crossing Case.—Steel Skeleton Buildings (*illustrated*).—New Column Section (*illustrated*).

CONSTRUCTION NEWS..... 46-48

Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

The Belt Line Railroad Co., of Philadelphia, has been enjoined by the Court of Common Pleas from laying its tracks on Delaware Ave., in that city. This action is due to the opposition of the Pennsylvania R. R. Co., through its branch line, the River Front Railroad Co. The judges deny at length the right of City Councils to grant privileges to lay track on this avenue.

The two Brooklyn elevated railways have so far evaded city taxation, and they now owe $944,726. They offer $250,000 in full payment, and the Corporation Counsel, Mr. Jenks, is reported as advising the acceptance of the offer. The city has made an effort to collect these taxes, and the companies have fought the assessment on the ground that it was too high as compared with adjoining property. The basis of assessment was $420,000 per mile for the wide, and $320,000 for the narrow structure. Mr. Jenks thinks this is excessive, and that in his judgment, based on the report of the engineers, the actual average cost of the elevated roads was not far from $265,000 per mile. Mr. Jenks thinks 70% of the cost of the roads is a fair figure for taxation.

The trolley resolution, passed by the Council of Brooklyn on Dec. 21, has been vetoed by Mayor Boody, on the ground that he wants more time to consider the question. He says it has not yet been shown that any city of the size of Brooklyn is justified in adopting the trolley system on its street railways. He further objects that the city is to receive no equivalent for the new conditions imposed, and says the system is dangerous to life.

The Pittsburg Bridge Co., Pittsburg, Pa., has been awarded the contract for constructing the new train-sheds for the St. Louis (Mo.) Tunnel & Terminal Railway Association. The sheds when completed will cover 10 acres. About 2,000 tons of steel will be required. Pegrani's patent truss will be used. Mr. W. W. Curtis, M. Am. Soc. C. E., Owing's Building, Chicago, is the company's Western representative.

Herculite is a new explosive invented by Mr. Albert Palle, of New York. It is said to have a base of sawdust, camphor and nitrate of sulphur, with other ingredients yet kept secret. Experiments lately made at Ravenswood, L. I., are claimed to have been satisfactory, showing the powder to be very powerful. The cost is stated to be "six cents per pound."

A street railway cable, for the Tenth Avenue line in New York, lately shipped from Trenton, N. J., was 33,000 ft. long, and weighed on its reel more than 30 tons. Special cars are used for the transport of these cables, and the freight on one reel, from Trenton to San Francisco, is said to be $900. Excellent cables are now made in San Francisco. As illustrating the life of cables for street railway purposes, Mr. James C. Robinson made the following statement at the recent convention of street railway men in Pittsburg, Pa.: "On the Temple St. cable road at Los Angeles, Cal., the record showed for a cable 12,380 ft. in length a period of 3 years and 2 months of continuous wear, during which time 720,681 miles were run. The Market St. and Geary St. roads in San Francisco, show, respectively, 1 year and 8 months for 106,225 miles, and 2 years for 119,153 miles run. On the Grand Ave. road, Kansas City, 18,000 ft. of cable gave constant service for 1 year and 10 months, 135,872 miles, the uniform speed being at the rate of 14 miles per hour; while the Metropolitan cable road secured its success with 1 year and 7 months and 102,359 miles. In Denver a cable 24,000 ft. in length, running around several right-angle curves, made a record of 1 year and 8 months, with 144,000 miles to its credit; while a 22,000-ft. cable, operated by the same company, attained a record of 19 months with 137,280 miles, on a road embracing a 7% grade and 4 right angle curves. It is said that the average life of the cables throughout the country is increasing. At present it is about 14 months, with from 70,000 to 80,000 miles of service. (Eng. News, Nov. 7, 1891.)

The most serious railway accident of the week was a head collision Jan. 5, at the Aladdin switch near Hannibal, Mo., on the Wabash R. R. Two express trains should have passed at this point, but owing to the fog the westbound train, which should have been sidetracked, ran past the switch and collided with the eastbound train which had the right of way; 6 persons were killed and 9 injured, one of them fatally. Three cars were burned. Another head collision occurred Jan. 6 on the New York, Ontario & Western R. R., near Smyrna, N. Y. A mixed train was run into by a light engine, owing to the carelessness of the engine driver of the latter and there were 3 men killed and 5 injured.

Three wooden highway bridges over the Long Island R. R. at Jamaica, N. Y., were torn down Dec. 30 by the boom of a steam excavator which was being hauled at the rear of a freight train. The water main crossed one bridge, and was broken, the water pouring down on the track for some time before it could be shut off.

Some very successful blasting has been done by Mr. C. L. Kahlback, at the Little Passaic Falls, about four miles above the main Passaic Falls at Paterson, N. J. The explosive used was pure blasting gelatine, costing about 50 cts. per lb., whereas dynamite could have been had for less than a third of that money; but the effect was that only 1,400 lbs. of explosive was needed to take out 8,000 cu. yds. of hard seamy trap rock, every hole in which was full of water. The excavation averaged about 14 ft. deep and 18-ft. holes were used, 1¼ ins. at bottom, rows of 5 to 7 holes being fired at once by battery. Hardly a single stone was thrown more than 20 ft., yet the rock was very completely shattered. It was estimated that to take out the same rock with black powder would have cost $25 to $30 per cu. yd. The work is being done to throw the fall back (up stream) about 500 ft., the excavation being about 80 ft wide.

A bill to provide for the examination and licensing of land surveyors has been prepared by the Ohio Society of Surveyors and Civil Engineers, which it is proposed to present to the legislature this winter. It provides for a board of three surveyors to inquire into the qualifications of and issue licenses to persons desiring to practice in Ohio; to establish and maintain meridian lines and standards of length; to inspect and approve instruments used by licensed surveyors; to arrange a uniform system of making and preserving field notes and maps of surveys, and to act as an advisory board upon difficult questions of surveying practice submitted by licensed surveyors. After the passage of the bill it shall be unlawful for any but licensed surveyors to practice land surveying, but persons who have been in actual practice for ten years and graduate civil engineers who have had five years' experience are to be entitled to receive licenses without examination. Only licensed surveyors are to be eligible for the office of county surveyor. The use of the magnetic needle for measuring angles between land lines is prohibited, and the placing of permanent monuments at minimum intervals of 1,000 ft. is made obligatory. The licensed surveyors are to give bonds, and are to file records of all surveys with the county surveyor. When called as expert witnesses the fee is to be $5 per day, in addition to mileage. The bill is not to prevent any person from making topographical or railway surveys, except so far as connecting these surveys with land lines is concerned. Another bill is to provide for the placing of permanent and sufficient monuments at all intersections of land or property lines. The monuments are prescribed as follows: (1) A cut and dressed stone not less that 6 ins. square on top and 2 ft. long, with a cross or drill hole on top; (2) a granite bowlder not less than 30 ins. high, with a drill hole 1 in. deep at the point of intersection; (3) an iron stake not less than 4 ft. long or 1 sq. in. section; or (4) a 2 in. earthen tile, set vertically, with its center on the intersection to be marked and filled with charcoal or brick dust, or other material approved by the state engineer.

The smoke nuisance in Chicago has been taken up by a committee of five men representing 19 Chicago clubs. This committee has filed articles of incorporation and intend taking vigorous measures against smoky chimneys. They will proceed at once to elect officers and establish headquarters and a bureau of information. The program is that a secretary, attorney and competent well known engineer shall be employed, a list of all smoking chimneys made out and the owners of the chimneys presented with the list and requested to abate the nuisance. The services of the committee engineer will be offered to parties seeking to prevent their chimneys from smoking. No one device will be favored and all inventors are to have an equal showing and be judged by their results. It is hoped by this method, and the co-operation of the citizens and the city press, to rid Chicago of its present smoky appearance and give the visitors to the World's Fair in 1893 a clear view of the sky. Unless more earnestness is shown hereafter than heretofore, however, we greatly fear that "Hope tells a flattering tale, delusive, vain, and hollow."

The Chicago & South Side Elevated Railway (known as the "Alley road"), running southward from Congress to Thirty-ninth St., alongside of the alley between Wabash Ave and State St., has sold sufficient bonds to enable it to complete and operate the road as far as Thirty-ninth St. by April 1, it is announced, and to complete it to Jackson Park and the Exposition Grounds by Jan. 1, 1893.

The Croton water shed, according to the late exhaustive report of Chief Chemist Martin and Dr. Beebe to the New York Board of Health, is seriously contaminated by sewage matter. No less than 2,000 specific cases of pollutions of the streams in that region are set down in the report. The situation is summed up as bad and needing speedy relief, but no direct recommendation is made.

Electricity is to be introduced as a motive power in a large flour mill to be built in St. Paul by Mr. Kingsland Smith. If it proves as successful as expected, the water power of St. Anthony Falls will be used only for generating electric power for the mammoth mills of St. Paul and Minneapolis. Mr. Smith is a practical miller of 30 years' experience and has been experimenting for a year past on electrically driven mill machinery.

A new source of the Nile has been "discovered" by Emin Pasha. Whether this is so or not, he has made material progress in the survey of the Upper Nile region. Working with Dr. Stuhlmann he has found the Kifu, a hitherto unknown river, which flows north about 230 miles and empties into the southern end of Lake Albert Edward. The existence of this river alters much the hydrography of existing maps and practically wipes out the Rusizi River and Alexandra Lake of Mr. Stanley. But as Emin Pasha has not fully explored the Kifu, traversing only its lower portion and mouth, there are further discoveries to be made up stream. In fact, we yet know comparatively little of the complicated system of rivers and lakes which ultimately form the Nile.

The surveys for the Hawaiian cable have been completed and the survey steamer "Albatross" has returned to San Francisco. In latitude 33°, longitude 132° the shoal found by the "Tuscarora," 15 years ago, was again encountered. The water suddenly shoaled from an average of 2,700 fathoms to 300 fathoms. By going 20 miles north the average of 2,700 was maintained. In latitude 32°, longitude 135° irregularities were again discovered but nothing less than 2,000 fathoms was noted. This depth continued regular until the 137th meridian was reached, when 3,200 fathoms were encountered, the deepest water met with. This deep water extended only three miles when 2,400 was reached. Elevations were found at the 139th and 143d meridians, showing 400 and 700 fathoms, followed by 2,700 fathoms. Beyond the 149th meridian the depth was uniform at about 3,000 to longitude 153°, and about 180 miles East of Honolulu a submarine peak was found showing 1,400 fathoms on top. The water deepened to 2,500 fathoms as the islands were approached. Just north of Maui Island the bottom is rugged and a depth of three miles was found. No good landing place has yet been determined upon at the Hawaiian end. It is believed that the volcanic shoals indicated can be avoided with little diversion in the general line.

The signal plant of the London & Northwestern Ry., England, is said to include 1,482 signal towers, 31,500 levers and 17,000 signals. The road has about 1,876 miles of track.

Electric traction is under consideration by the Illinois Central R. R. Co., and Messrs. J. W. Doane and Norman Ream, of the Board of Directors, have been appointed a committee to investigate and report upon the feasibility of using electric traction in ordinary railway service, with a view particularly to handling trains in and near Chicago, on account of the city's agitation against the smoke nuisance.

THE LATE JAPANESE EARTHQUAKE.

We are indebted to Mr. S. Tanabe, of the Imperial University of Japan, for a series of photographs, from which we make the three accompanying views of some of the destructive effects of the terrific earthquake of Oct. 28, 1891, which caused a total loss of over a hundred million dollars, with thousands of lives.

Fig. 1 shows a view of the castle building at Nogaya, built about 300 years ago. It is five stories high,

Fig. 1. The Castle Building, Nogaya, Japan, After Earthquake of Oct. 28, 1891.

of wood, covered with plaster, and is the tallest building which withstood the earthquake. So far as appears from the photograph, it was not even cracked, the lines which look at first sight like cracks being really the rain-water pipes.

Fig. 2 shows a river embankment in the earthquake district which was cracked to pieces in the remarkable way shown. We understand that a very considerable quantity of such embankments were thus shattered. It is interesting to note in this connection that many of the Japanese rivers have their beds elevated high above the level of the plains traversed, and are virtually troughs with the water confined by levees. This is caused by the enormous quantity of sedimentary matter washed down from the hills. The breaking of these troughs by the late earthquakes was responsible for much of the loss of property and life.

Fig. 3 shows the destruction of two piers and the three spans depending on them of the Nagara railway bridge. The complete structure consisted of five 200-ft. spans and four 100 ft. spans, having wide sandy flats to pass over, which alone are visible in the view, the river itself not showing. The complete destruction of two of the piers will be seen to have partially destroyed the pier in the foreground by dropping one end of the span so that it acted as a lever to pull apart one of the cast iron columns. The spans themselves would appear to have been very little injured.

Other views, which we do not reproduce, showed the practically complete destruction of a post office building only five years old.

THE YORK ROAD TUNNEL OF THE BALTIMORE BELT RAILROAD.

By Milnor P. Paret, M. Am. Soc. C. E.

[With inset.]

In Engineering News of Dec. 12 and 19, a description was given of the railway which is now being constructed in the city of Baltimore to give the Baltimore & Ohio and Western Maryland railways ready access to the heart of the city. Besides the long tunnel under Howard St., which was then described, and which is the most important and difficult piece of work in the construction of the railway, a short tunnel, between 600 and 800 ft. long, is being built in the northern part of the city, to carry the line underneath York Road. This tunnel is being constructed by a system entirely different from that in use at the Howard St. tunnel, indeed, so far as known, it is a different system from anything ever before used in tunnel construction.

The system consists in brief of driving two bottom side drifts with rectangular shields, pushed forward by hydraulic jacks. These are followed by a semicircular roof shield advanced by the same powerful tools. The timber lining of the side drifts is put in place under the rear plate of the shields. It will be seen that the system is an adaptation of the hydraulic shield system of tunneling which worked so successfully in the clay at the St. Clair tunnel and the City & South London subway.

The York Road tunnel, like the Howard St. tunnel, is being driven through a loose sandy material requiring constant support. To start the work a shaft 33 ft. deep was sunk 50 ft. from the east side of the York Road. The shaft is 34 ft. wide and 24 ft. long outside of timbers. It was made of these seemingly large dimensions to permit the semicircular roof shield to be readily framed.

A power house is located near the mouth of the shaft, and contains the hydraulic pressure pumps, the drainage pumps, and the hoisting engine which works the shaft derrick. An elevator in the shaft is contemplated, to be worked from the same power house. The tunnel will probably be lit by incandescent lamps during construction, current being taken from the electric light company's wires, which pass along the street.

Fig. 2. Effect of Earthquake on River Embankment.

The hydraulic pressure pump and all the hydraulic plant used in advancing the shield were furnished by Messrs. Watson & Stillman, of New York City, who furnished also the hydraulic plant for the St. Clair tunnel, described in Engineering News, Dec. 20, 1890. The working pressure is 4,000 lbs. per sq. in., the safety valve being set at that limit. All pipes and fittings were tested to a pressure of 6,000 lbs. per sq. in. after setting up.

The drainage pump used is a New Pulsometer No. 6, set on the side of the shaft, about 10 ft. above the sump. The material thus far penetrated is a coarse, clean and compact sand. But little water has thus far been struck, and the drainage pump has disposed of it by running two or three times a day for a few minutes at a time.

The side walls in the bottom drifts have now been completed for a distance of 113 ft. on the south side and 97 ft. on the north side. The top drift has been carried in with the large semicircular roof shield far enough to permit the completion of 38 lineal ft. of the brick tunnel lining in front of the shaft.

The Side Shields.—The two rectangular shields which drive the bottom side drifts are duplicates of each other. Their construction is fully shown on the accompanying inset. They are 9 ft. high and 8 ft. wide outside the cutting edges, and 8 ft. long over all. The top, bottom and sides are of ¾-in. steel plates. The shield is braced by two tension rods connecting the opposite corners of the shield, and supplied with turnbuckles for tightening. Across the front of the shield are two horizontal shelves of ¾-in. steel plate, extending back 2 ft. 4 ins. from the cutting edge. These plates not only form supports for the side plates, but take the place of a bulkhead at the front of the shield. The sand runs down on each shelf a distance determined by its angle of repose. These shelves are joined to the side plates by a 3 × 4-in. angle iron.

The four sides of the shield are further strengthened by three 12×16-in. timbers, placed side by side, and held from sliding on each other by cast-iron keys of cross-shaped section, with arms 1 in. thick. To facilitate putting in these timbers and making them fit snugly the sides of the shield, one of the horizontal joints of the iron shell is left open ½ in. and bolts are used instead of rivets. After the timbers are in place, these bolts are screwed up tight. To the sides of the shield are bolted cast-iron brackets, which butt against angle-irons and receive the heads of the four hydraulic jacks, each of 80 tons capacity, which force the shield ahead. A 2-in. oak cushion is placed between the head of the ram and this bracket.

At the rear of the shield the top and side plates project 19 ins. farther than the bottom plate, and furnish an apron under which the oak timbering is put in place. The sills are 2 × 12 ins. × 8 ft.; the posts are 6 × 12 ins. × 7½ ft., and the caps are 8 × 12 ins. × 7 ft. 9 ins. The foundation is started directly on the sills and the side walls are carried up close to the bottom of the caps, or 7 ft. above sub grade. The top of the caps is ⅛ in. below the springing line of the arch. Occasional stretchers or braces are placed along the top and bottom, butting against short waling pieces, which cover a width of three or four posts, to keep the posts from being forced inward by the pressure of the earth back of them.

The Semicircular Roof Shield.—As the lower drifts are advanced, a track is prepared for the roof shield. Upon the top of each timber cap of the lower drift a cast-iron bearing plate is attached by a wood screw through its center. These plates are placed with their centers 14 ins. from the outer end of the cap. They form a guide and bearing for the friction plate and channel iron on which the semicircular shield moves forward. To prevent the timber caps of the drift from getting out of line, they are keyed with cast iron timber keys ¾ in. thick, with ¾ in. lateral grip and 8 ins. long.

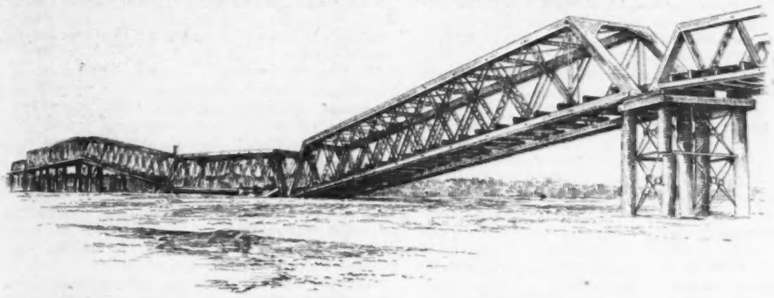


Fig. 3. Wreck of Nagara Railway Bridge, Japan, by Earthquake of Oct. 28, 1891.

The semicircular shield was designed by Major Richard Randolph, Chief Engineer of the Maryland Construction Co. Its length over all is 13 ft. 8 ins., and the radius of the inner surface of its shell is 15 ft. 4 ins. The shell of the shield is made up of ¾-in. steel plates, each 6 ft. 10 ins. long (measured in a direction parallel with the axis of the tunnel) and 4 ft. wide. The separate plates are bolted together by butt joints, the bolt heads on the outer surface being countersunk. The cover strap for the joint is 8 ins. wide and ¾ in. thick. It is fastened with 1-in. bolts spaced 4 ins apart and 2 ins. from the edge of the plate. To give stiffness to this shell, two circumferential ribs of 4 × 6-in. angle-iron are bolted to it at a point 12 ins. back of the cutting edge and 20 ins. in front of the rear of the shell. These angle-irons are in 4-ft. lengths, the joint between them coming at the center of the plate. The front angle-iron, which sustains the thrust of the hydraulic jacks, has each 4 ft. section bolted to the shell by two rows of rivets along the central part and a single row of bolts at the ends.

The space between these angle-irons is lagged with 12 × 16-in. timbers, running lengthwise of the shield, each set of four timbers being keyed together at two points by cast-iron keys like those used in the rectangular shield timbers.

The shield is pushed forward by 12 hydraulic jacks, each of 100 tons capacity, spaced 4 ft. apart. Each jack is opposite the center of one of the 4-ft. plates of the shield and is at the center of a group of four timbers. Each foot or lower edge of the shield is shod for its whole length with a 15 × 2½-in. channel, with the flanges down. In the hollow of this channel is bolted a 13 × ⅝-in. plate, beveled to ⅜ in. at the front. This "runner" slides on the cast-iron bearing plates on top of the caps over the bottom drift, the flanges on the channel guiding the shield in a straight line, as they fit over the bearing plates on the post caps.

It is expected, by the use of this shield, to avoid the necessity for timbering in the tunnel, the brick lining being laid under protection of the rear plate of the shield as fast as it moves forward, and forming the abutment against which the hydraulic jacks work in pushing the shield ahead. To prevent the head of the jack from crushing the bricks, however, a cushion is provided for each jack. The head of the jack is received in a cast-iron socket bolted to a timber segment, 22 × 47 ins. and 8 ins. thick. The casting has a bearing surface on the timber 15 ins. square. To the under side of each of these timber segments, four wooden shutters are bolted, the bolt passing through a slot which allows the shutters to be moved back, so that their ends are 7 ins. to the rear of the face of the segment, or forward until they are flush with it. These shutters furnish a temporary support for the brickwork, taking the place, in fact, of the usual lagging. After the shield has been moved ahead far enough to allow a new ring of brick to be put in place, the masons begin the work, moving the slotted plates out to support their work as fast as they progress from the springing line toward the crown. Small angle-irons, running radially, are placed on the under side of the third segment-timber jack-head from the bottom, on each side and at the outer end. These angle-irons thus form a bench for a shelf from which brick work can be started, and enable four bricklayers to work on the arch at a time, two (one on each side) from the side walls to the angle-irons, and two from the angle-irons to the crown.

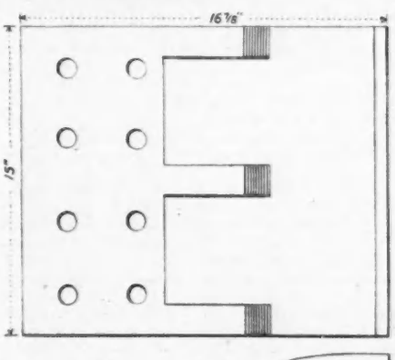


Fig. 1. Sketch of Re-enforcement Plate for Tunnel Shield.

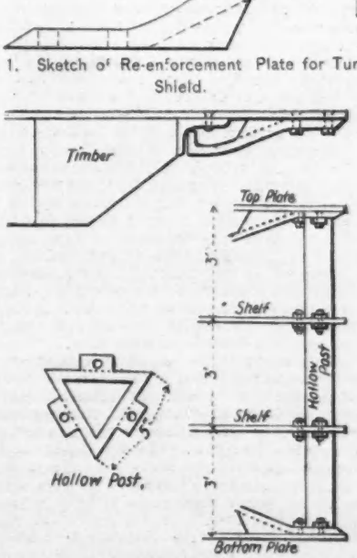


Fig. 2. Sketch Showing Arrangement of Re-enforcement Plates, and Post to Prevent Sagging of Shelves on Rectangular Shields.

It will be noted that the construction of the shield only allows a forward movement of 8 ins. at a time, or one brick length; this will not enable the carrying of any good bond through the brickwork, and none is at present proposed.

With everything in good running order, it is expected to build a section of the arch (8 ins.) about every two hours. The shield can be driven ahead this distance in about ten minutes, so that the bricklayers will be kept busy; and the mortar being always quite green, it is desirable to have the jack-heads butt against a full section of brickwork. It is purposed to put in two more of the small angle-irons referred to above, one 8 ft. each side of the center of the crown; thus enabling six bricklayers to work at once. A platform will be slung under the shield for the use of the bricklayers working near the crown.

The bottom side headings have been advanced with the rectangular shields at the rate of 3 ft. to 7 ft. per day, working one 10 hour turn. The rate of progress has been limited, however, by the rate at which the dirt could be taken out, it being handled on wheelbarrows. With a track laid in the drifts and dump cars hoisted on an elevator, as at most of the shafts of the Howard St. tunnel, much more rapid progress should be possible. It is also true that work has not been pushed on these drifts, as the work on the large semicircular shield for the top drift was considerably behind.

In driving forward both the rectangular and the semicircular shields, the weak point has been found to be the unsupported portion of the shell which forms the cutting edge, in front of the angle iron and timbers. This was bent down by the resistance of the material in front and the pressure of the outside material. It will be noticed that these "cutting edges" were left the full thickness of the plate, and were not beveled to a sharp edge as in the St. Clair tunnel shield. This perhaps explains in some degree the bending which occurred.

To remedy it, measures were taken to firmly support the cutting edge. The accompanying sketch, Fig. 1, shows the cast iron re-enforcement plates which are attached to all the shields. Those on the rectangular shield were 7 ft. 4 ins. wide, extending from the angle-iron in one corner to that in the other. On the semicircular shield the plates were 15 ins. wide and 16⅞ ins. long. One was placed at each joint of the shell plates and fastened to them with eight tap bolts; and one was placed at the center of each plate, directly in front of each jack, and was fastened to the shell with six tap bolts.

The horizontal shelves in the rectangular shields also gave some trouble by sagging, and they have therefore been given additional support by the insertion of cast iron triangular posts between the shelves and the top and bottom plates. These posts are set on the front edge of the shelves with their sharp edge toward the front, and are bolted fast by flanges on their feet. The arrangement will be clearly seen by reference to Fig. 2.

In framing the semicircular shields, after the centers carrying it were struck, the shield was found to have settled a few inches at the crown, raised a little at the haunches and kicked out slightly at the heels or springing line.

The 12-in × 16-in. timber lagging of the shield had to follow the sections of steel shell, since the strap connecting the butting ends of the two 6 ft. 10-in. plates, came at the center of timbers and had to be bolted to the two plates. The key timber had to be put in place from below, and was reduced in thickness a couple of inches, for slight irregularities in the timber caused a creeping up of that amount. When the centers were struck and the weight of the shield came on the timber lagging, the joints between them necessarily closed up and the angle-iron ribs of the shield were not stiff enough to prevent the buckling referred to.

An attempt was made to remedy it and try to put in a heavier or thicker key by raising up the shield with jacks taking a bearing under the crown; this only resulted in raising the whole shield bodily, showing that it had taken a more or less permanent set. Possibly the difficulty might have been avoided could the timber lagging have been keyed up in advance of the steel shell or by tie rods from heels to haunches. However, the trouble is by no means serious and no further tendency to buckle has been noticed or is anticipated.

The shield is now being driven ahead one length, using short poling boards in advance, carrying them down a little at the haunches and up a little at the crown, with a view of possibly forcing the shield into more true shape.

It seems possible that the shield may not have as thorough a test as is desirable, owing to the fact that the material showing up in the advancing side

drifts is becoming very hard, almost a soft sandstone, through which it is doubtful if the shield will cut.

However, there are many advantages besides its penetrating ability which this shield can, and no doubt will, illustrate.

The writer is indebted to Mr. D. W. Hemming, Assistant Engineer in charge of the York Road tunnel, for many courtesies.

In this connection an additional note on the methods in use at the Howard St. tunnel may be of interest. Besides the actual tunneling in progress, which has been heretofore fully described, a section of the tunnel near its southern end is being built in open cut, a narrow trench, in which the side walls are built, being excavated at the sides of the street. As already stated, the street is crowded with traffic and the disposal of the excavated material in such a manner as to neither delay the work nor add to the traffic in the street is obviously desirable. This has been accomplished by the use of the cable transport system. An endless cable 600 ft. to 800 ft. in length is strung over the trench for its whole length, and the buckets of earth are carried along it to dump carts at the end of the line. On the return trip of the bucket, necessary materials are carried to the work.

EARTHEN VS. MASONRY DAMS.

[Concluded from page 21.]

5th. Earthen Dams.—An earthen dam can only be used where it is possible to carry all waters around the structure. It does not seem wise to use earth on solid rock foundation, as it becomes difficult to make a tight joint between the earth and the rock. A masonry dam is best for such a site. Nor is it best to attempt the use of earth on boulders or coarse gravel. Leakage under the dam will be almost certain to ensue, and this leakage will be likely to take with it the lower toe of the dam and finally threaten its destruction.

Clay, sandy or gravelly clay, fine sand and loam are all possible and proper foundations for earthen dams, and all form materials from which dams can be built and maintained. Of the materials enumerated loam is the poorest; then come sandy clay, sand, clay and the best, gravelly clay. The most worthless material of which an engineer ever attempted to build a dam is shale It will leak, slip and slide.

Sandy clay is not desirable, especially if the sand is fine and inclined to become quicksand in the presence of water. It is likely to slip, and when it once starts to sliding its angle of repose may be as low as 6 or 8 to 1. Sandy clay, in which the sand is coarse, is a good dam material, but it is best to make sure that it contains but little fine sand before recommending its use. Loams vary in value for dam construction. Those containing much vegetable matter only partially decomposed are almost worthless, while those with clay largely entering into their composition are good. A good, safe structure can be built of the lightest sandy loam if only enough of it is used and if the upper face is protected by mattress and riprap from wave action. Slopes as low as 4 to 1 may be necessary.

Fine sand is by no means an ideal material for an earthen dam, but it is a fairly good one. It has a great advantage over other materials in that it needs no tamping and no special care in depositing it in the bank, but will form of itself a homogeneous mass. Any man who understands handling teams and working to stakes and slopes can build a dam of sand after the site is properly cleared and prepared. For a reservoir dam which will be wet the greater part of the time the sand should have the outer slope 3 to 1 and the inner slope 4 to 1, and the inner slope should be protected by riprap laid on a brush mattress. The riprap alone may settle unequally into the sand, so offering breaks through which the waves may get at the sand and wash it out. Many permanent structures have been built of sand. No burrowing animals will work in it, as their hole will cave in on them as fast as made. Gravelly clay and pure clay are the ideal materials for earthen dams. One is about as good as the other. If preference is given to either it should be the gravelly clay.

The proper cross-section for an earthen dam of good material is about as follows: Crest 8 to 10 ft. wide and 3 to 6 ft. above high water line, depending on the size of the reservoir and the likelihood of heavy wave action; inner slope 3 to 1, outer slope 2 to 1. The inner slope should be riprapped above low water mark 12 to 15 ins. thick with rock varying much in size—say from 1 cu. ft. down to coarse gravel—the object being to present as smooth a surface as possible to the waves.

In preparing the site many engineers—a few years ago all engineers—specify that it should be cut into steps forming a succession of vertical and horizontal faces. This, seems to me bad practice. The one thing to be avoided is plane surfaces, especially those which are vertical or nearly so, the objection to the vertical surface being that the earthwork may settle away from it. All smooth surfaces, at whatever angle they lie, are to be avoided as offering a possible passage for a thin film of water. For these reasons it is probably better to specify that the site should be cleared of all perishable matter and large stones and left with a rough surface so that the first material put in will bond readily with the old ground. This is not an important point, however, as good construction can and does result from either method.

A puddle or masonry core formed a part of all earthen dams constructed up to within the last few years. I think that all books written on the subject still recommend its use, and probably the large majority of engineers to-day insist on such a core. Nevertheless, it is almost certain that its presence in a dam is an element of weakness rather than of strength. The effective upstream face is that point in a dam at which the pressure of water ceases either by the water ceasing to penetrate the body of the dam or by its having free egress from the downstream side. The puddle or masonry wall, if it come up to its builder's purpose and is water-tight, will stop the small amount of water which will inevitably come through a new earthen dam. This water will gradually accumulate in the earth immediately against the core and finally, as it is added to from the reservoir above, permeate the whole body of the dam above the wall, and the water pressure, intended to be exerted against the upstream face of the dam, will be directed against the core, resulting in rendering this wet material absolutely useless except as a partial support to the core. The whole duty of the dam is performed by the masonry or puddle wall and the material below it. The masonry is especially objectionable for the reason that it is never built of sufficient strength to withstand the water pressure by itself. When this pressure comes against it some is transferred to the earth backing below. The earth will probably yield and then the masonry wall follows it. A crack in the masonry and a leaky or broken dam result. A puddle core may fail in the same way, although it is not so likely to crack as is the masonry.

It has been customary to specify that an earthen dam should be built about as follows: 1. A core of clay, or gravel and clay, puddle. 2. Selected material on each side of the core. 3. The rest of the dam of poorer but available material. This results in a dam composed of five layers, each of different material, density and weight, and each of which is likely to settle a different amount. In addition it is specified that the dam must be carried up in layers of from one to two feet in thickness, and each thoroughly compacted before the next layer is put on. It would seem as if a worse form of construction could not be devised. The result is a structure unhomogeneous in character and with a series of horizontal surfaces of cleavage through it.

The ideal earthen dam is one which is of the same density throughout, which is composed of material practically impervious to water, and which forms in itself and with the natural material on which it rests a perfectly homogeneous mass. In practice it is extremely difficult to obtain such a structure Enough impervious material for the whole dam is seldom found within reasonable handling distance of the site. This necessitates using a mixture of different materials, and so the density may vary. The engineer must come as near as possible to the ideal form. In my opinion, the following method will give a good structure. If enough good material for the whole structure is not to be had, the upstream third or fourth of the dam must be made of the best available, and the poorest put into the lower portion. Bear in mind that the dam will be safe if built so that the upper third is impervious, or nearly so, to water, and so that any water which may soak through this upper third will have free egress from the dam on its lower side. In other words, keep water out of the dam if possible, but quickly get rid of what little does pass the upper third.

The site, as before stated, should be cleared of all perishable material and, except over its lower third, of all rock and its surface left rough. All material should be damp enough to pack well when put in. This result can probably be reached most effectively by irrigating the borrow pits before ploughing. The dam should not be carried up in layers but the whole surface gradually raised, the downstream edge being kept the highest all the time, but the highest point ought to be at no time more than three or four feet above the lowest. No runways should be allowed, but the teams should be driven over the whole surface, this being done to obtain the most uniform density possible. It should be borne in mind that it is not so desirable to get portions of the dam packed absolutely solid as it is to get a structure of the same density throughout. Settlement does no harm so long as it is uniform and so long as the fill does not settle away from any abutting structures, such as the walls of headworks, etc.

In this method of construction, the puddle wall is practically transferred to the upstream face, where it belongs and this face is likely to become the effective face of the dam. As stated before, it should be protected by riprap. A low fence of plank may be built along the upstream edge of the crest to break the force of any waves which are so high as to go over the top of the dam.

Whenever possible without an excessive expenditure of money, the outlet to the reservoir should be through natural material rather than through the earthen dam. It is safe to make the assertion that three-fourths of the failures of earthen dams are caused by water first percolating along beside an outlet pipe or back of a masonry wall. Iron pipes ought never to come in contact with the earth but should be surrounded by masonry—preferably laid in a tunnel.

Where earth is to come in contact with masonry the latter should be laid up with battered face next to the earth, the slope not steeper than ¼ to 1; and, in case of walls going through the dam, cross walls should be built out into the earth at frequent intervals with face and ends battered, so that in case the earthwork settles it cannot by any possibility settle away from the masonry. Especial care should be used in packing the earth against the walls to see that no cavities are left. At the best, the junction of earth and masonry forms a weak point and the greatest care should be exercised to make the bond as good as possible.

Some may object that the slopes recommended are too flat, but experience has shown that not to be. They are the slopes most frequently used on levee work where the fill is wet for only a few days or at the most a few weeks at a time. While a dam with 2½ to 1 upstream and 1½ to 1 down stream slopes may stand, there is danger of failure. One and a half to one is not the permanent angle of repose of any earth, 2 to 1 is nearer to it. Any of you who are inclined to doubt this statement will be convinced after measuring a few old railway embankments.

6TH. LOOSE ROCK DAMS.—It is only in the last few years that the loose rock dam has been looked on with favor by engineers, and it does not yet attract as much attention as it deserves. When set on the proper foundation it makes a very safe structure, probably the safest known dam. Loose rock can set on solid rock or bowlders.

Some engineers recommend the use of loose rock in overflow dams under certain conditions. It is likely that in a cañon where plenty of rock can be cheaply thrown into the channel of the stream a good overflow dam can be built by pure strength and awkwardness simply by throwing in rock in large masses until it comes to rest. It is hard to say what the down stream slope would be, probably as flat as three to one, depending on the volume of water in the stream. The up stream slope would be about one to one. Such a dam is preferably built in a medium stage of the stream rather than in extreme high or low water. A good flow will assist in scouring out the sand and gravel on the site of the dam and in packing the rock. In case there is a considerable quantity of loose material overlying the foundation on the proposed site, rock filling should begin a little above the up-stream toe of slope. As soon as the stream's level is raised and a waterfall formed the loose material will begin to scour out and the rock will roll down stream into the cavity. If the minimum flow of the stream is so small as to make it necessary to have the dam watertight, it can be back filled with earth on a three on one slope and riprapped. It is probable that the crest of such a dam would be lowered considerably during the first few floods which went over it, and the construction could not be used except where such a lowering could be stood and could be easily and quickly replaced when the flood subsided.

The most effective form of loose rock dam is one in which no water is allowed to go over its crest and where it is backfilled with earth. In this form the crest of the rock work should not be less than 8 or 10 ft. wide, the downstream slope 1 to 1 or 1¼ to 1, and the upstream slope ½ to 1, possibly a little steeper. The earth backing should have a thickness at the top of 6 to 8 ft and a slope of 3 to 1 and be riprapped the same as an earthen dam. Some dams have been built with the downstream slope ¾ to 1, but it seems best to me to let the rock take its own angle of repose, which with a little urging will be nearly, if not quite, so flat as 1½ to 1. Those with steeper slopes have the surface built up as a dry wall.

There is a dam of this description across the Rio Pecos a short distance above Eddy, N. Mex. A brief description of it and of the method of construction and the troubles they have had with it will bring out several points in connection with this form of structure. The dam is about 1,000 ft. long and has a maximum height of about 15 ft. The east end abuts against a limestone ledge from which was taken the rock used in construction. The channel of the river was close to this bank and had cut down onto the solid rock. Towards the west end of the dam there was some 15 or 20 ft. of the light red soil of the Pecos Valley on top of the ledge.

The cross section of the rock dam is 12 ft. crest, lower slope ¾ to 1 (erroneously stated by some as 1½ to 1), upper slope between ¼ and ½ to 1. There is a scour box through the dam near its east end 37 ft. below its crest. The box is 4 ft. by 8 ft. in the clear and sets on a shelf cut in the solid rock. Its bottom is of 6 × 12 timbers laid crosswise and running out under the masonry walls which form its sides.

The east side is built right against the solid rock. The west side has the loose rock and earth filling against it. The top is 12 × 12 timber and the side walls are extended

into a parapet and wing walls at the upper end. The back of this wall is vertical and has no cross walls built out into the earth.

The rock filling commenced at the east end and the stream was turned over against the sandy loam which formed the west bank of the river. The water quickly cut it out and the whole base was thus cleared of soil. The rock was hand placed and solidly packed. The faces are built up dry walls. Owing to poor superintendence, the earth backing was not properly put in. The material used was the light sandy loam of the valley and was put in dry, with an upstream slope about two on one, and was not riprapped. A sudden flood came down, quickly filling the reservoir. When it was about two thirds full this earth filling suddenly slid away, taking a slope of 10 or 15 to 1—or practically level—and let the flood against the loose rock. The water poured through it and caused the utmost consternation. The headgates of the canal were not complete and could not be quickly raised, so they were blown out with dynamite, and the people of Eddy, some six miles below, took to the hills. The loose rock dam, although built of slopes undoubtedly too steep, stood the flood and remained practically intact.

Last winter the earth filling was replaced with 3 to 1 slope, and riprapped with 12 ins. of broken rock. This summer an enormous flood came down the river and found another weak place in the dam. This time the water is supposed to have followed along between the earth and the wing wall at the head of the scour sluice on its west side, and finally worked a hole through which it seemed to threaten serious damage. Heroic and long-continued work finally stopped the leak. It is not likely that this break would have done any considerable damage to the dam, even had it been left alone, aside from washing out a good quantity of the earth backing.

This trouble with the Eddy dam teaches an important lesson. As stated in the discussion of earthen dams masonry should not be carried through the body of the dam wherever it is possible to avoid it. This is especially true of the loose rock dam. If it is difficult to make a tight joint between masonry and earth, it is impossible to make it between masonry and loose rock, and in case masonry is carried through the loose rock, dependence must be placed solely on the earth backing to make a tight joint. In the Eddy dam the masonry was built with vertical back and no wings, and disaster followed.

The general design of the structure was good—the troubles gone through were defects of construction. Right here I want to call attention to the fact that no other kind of dam could have stood what this one has and remain intact. This dam well shows the safety of the loose rock form of construction. It is undoubtedly the safest possible form.

Problems of irrigation work are different in their nature, and require a different solution from those of any other class of engineering design. Owing to the fact that they are pioneer works and must of necessity precede the development of the country, and that the capital expended must come from outside and not from the section benefited, it becomes absolutely necessary to hold the first cost down to the lowest possible point. So that in designing such plants an engineer must aim at simplicity and at that form of construction which will put the water on to the land with the least expenditure of money compatible with safe and substantial construction. I have attempted no relative estimates of cost between the different kinds of dams, because the local features and surroundings will so largely control and modify the cost in each case that general estimates would be misleading.

THE STEEL SKELETON TYPE OF HIGH BUILDINGS.

The cut printed herewith should have appeared in our last number, but the engraver disappointed us. It gives a view of the twelfth floor of the Ashland Block, Chicago, looking from the interior court. The steel work, the veneer of masonry and the connection of the terra-cotta work with the steel skeleton show quite clearly.

PROPOSED BRIDGE LEGISLATION.

At a meeting of the Western Society of Engineers, Mr. A. E. Williams presented a draft of a bill prepared by him dealing with the appointment, qualifications and duties of deputy state engineers and providing for the construction and maintenance of highway bridges. The substance of this bill may be abstracted as follows:

The Governor is to appoint, by and with the consent of the Senate, and to commission as deputy state engineers, as many persons as shall make application; provided, that these applicants shall be qualified electors in the state, and practical civil engineers, skilled in the theory and practice of bridge building and of not less than five years' experience in such work. They must not be interested, directly or indirectly, in the building or repairing of highway bridges in the State of Illinois, during their term of office.

No person is to be appointed a deputy state engineer except upon the petition of at least 50 legal voters of the state, and upon presentation of a certificate issued by the Railway and Warehouse Commission of the State of Illinois, setting forth that he is qualified for the office.

Each deputy state engineer so appointed is to hold office for four years, unless sooner removed by the Governor; and to give a bond of $5,000 with sureties approved by the Governor, for the faithful discharge of his duties, and shall take an oath to that effect. He then shall have authority to execute the duties of his office anywhere within the state.

Whenever the officers of any municipality in the state desire to build or let the contracts for a bridge of a span exceeding 20 ft., they must first submit the plans, specifications and contract to a deputy state engineer, who is to approve or reject them, and report to the officers interested any recommendations he has to make. A copy of his full report, with copy of plans, specifications and contract is to be filed in the office of the county court, in the county where the bridge is to be built. It is made unlawful for the officers mentioned to erect a bridge on plans rejected by the deputy state engineer, or to pay for any part of it out of public funds.

If the examining engineer considers it necessary he may recommend that tests be made of the material to be used. Such tests shall be ordered by the municipal officers and made by a deputy state engineer. The contractor must then submit the certificate of this engineer, that the material fulfills requirements, before he can commence the erection of the structure. This certificate is to be filed with the plans, etc., in the county clerk's office.

The deputy state engineer is to examine the bridge upon its completion to see that plans and specifications have been fully carried out, and report its approval, rejection or modification under the contract. This report must be filed with the other documents in the case.

It is to be the duty of municipal officials to employ, every two years, a deputy state engineer to examine and report upon all highway bridges of spans exceeding 20 ft. in their jurisdiction. In case these officers fail to have these examinations made, or to make safe or close to traffic structures reported unsafe by the engineer, or to post notices fixing the maximum load a bridge will safely carry, they shall be personally liable for any accident happening due to this carelessness.

The fees for the services of the deputy state engineers may be agreed upon between the municipal authorities and the engineers; but in no case shall exceed the maximum schedule of prices fixed by the Railway and Warehouse Commission. This Commission is also required, from time to time, to fix a schedule of rates for the several classes of service of the deputy state engineers.

In this connection the November issue of the "Journal of the Association of Engineering Societies" contains an excellent report of a committee of the Western Society of Engineers on this subject. The report is very complete, but too long for more than mention here. It outlines the practice in America, England, France, Austria and Germany, and gives, in the form of appendices, the bridge regulations of England, France and Austria, the latter very detailed. It also quotes in full the Massachusetts law and the acts proposed by the Engineers' Club of Kansas City and by Mr. C. F. Stowell, formerly engineer of bridges for the State of New York.

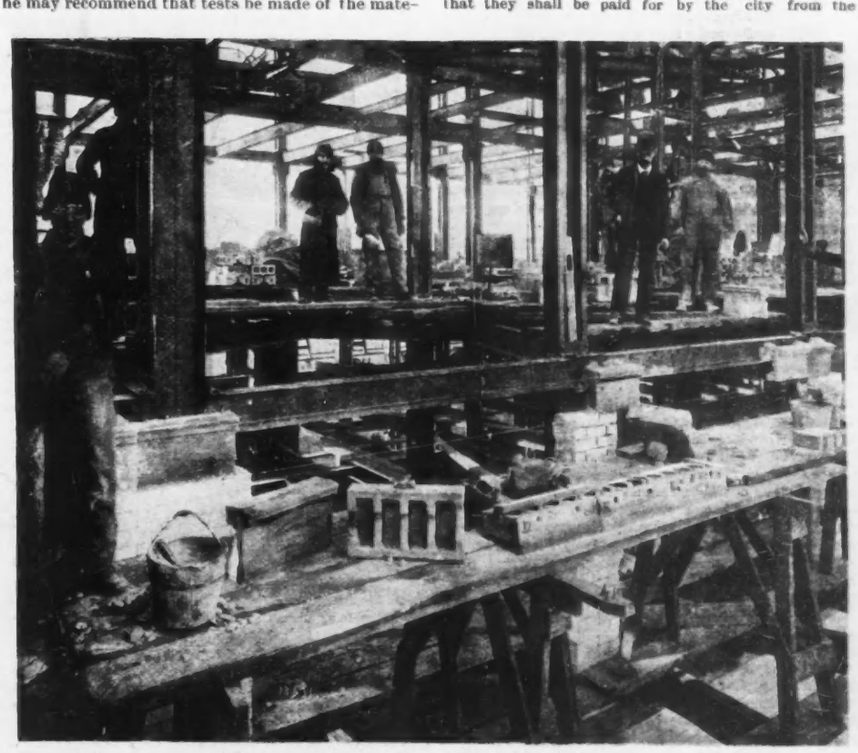
LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Issue of City Bonds.

The charter of Seattle authorizes the city council to issue local improvement bonds, and provides that they shall be paid for by the city from the proceeds of the assessments, by the improvement districts, "but the city shall be liable for the payment of both principal and interest." Such bonds, when issued, constitute a part of the city's general and primary indebtedness, and an ordinance attempting to make it liable only in the event of a failure to collect the assessments is invalid; and the bonds cannot be issued when the amount would increase the debt of said city in violation of the Constitution of Washington, forbidding any city to become indebted in any amount exceeding 1½ of its taxable property, except by the consent of three-fifths of its voters. Austin v. City of Seattle, Sup. Ct. of Washington, 27 Pac. Rep. 537.

Obstruction of Public Streets.

The laws of Kentucky allow municipal corporations to grant rights of way over the public streets and alleys only on condition that the use of the easement shall not obstruct or "unreasonably" impede the passage of person or vehicles. Act Ky., 1848, chartering the Lexington & Frankfort R. R. Co and empowering it (Sec. 14) to "construct such lateral or side tracks" "as they may choose" in Frankfort, to terminate at the Kentucky river, does not authorize the city of Frankfort to grant to the company a right of way through a narrow public alley for a branch railway, to be used exclusively for the benefit of a private firm, where the use of the tracks causes an "unreasonable" obstruction. The fact that, while cars are passing along a railway laid in a public alley, 400 ft. long and 16 ft. wide, the passage of vehicles drawn by horses is totally prevented, though for only a few minutes at a time, renders the use of the alley by the railway company an "unreasonable" obstruction.—(Commonwealth v. City of Frankfort, Ct. of App., Ky., 17 S. W. Rep., 237.)



VIEW OF PART OF TWELFTH FLOOR OF ASHLAND BLOCK, CHICAGO.

THE SURVEY OF ROANOKE, VA.

In March, 1891, a plan for the systematic resurvey of Roanoke, Va., was adopted by the City Council. The work was not begun until August. Since then work in the several branches has progressed very satisfactorily. The triangulation system is the only part completed. For a copy of the plan of survey, map of the triangulation system and other material subjoined we are indebted to Mr. Wm. M. Dunlap, City Engineer, and Mr. Geo. P. Wood, Engineer in Charge of the survey, which has many points of interest and novelty, especially in the effort to do a really high grade of work at moderate cost and in accordance with a systematic plan foreordained from the beginning. This plan, as adopted by the City Council, is as follows:

Name.—The name "Official Survey" shall be applied to all reports and business connected with the official survey of the city, and all information in the nature of field and office notes pertaining to the official survey shall be recorded and indexed under that heading. All maps resulting from the official survey shall, when provided by the Council, be published under the title "Official Map," &c.

Supervision.—The official survey shall be made under the supervision of the city engineer, and it shall be the duty of that officer to appoint all assistants needed on the work and see that they perform their respective duties, or in the event of their failure so to do to dismiss them; to order all material needed for the survey; to approve all bills of expense incurred by the city for this purpose, and to report progress of the survey as often as the Council shall direct. The city engineer shall direct the actual work of the survey through the medium of an assistant, hereinafter designed as the engineer in charge. It shall be the duty of the engineer in charge to receive and transmit orders from the city engineer and see that they are executed in an economical manner, and at all times to see that the information derived from field and office work is reliable and accurate. All other assistants will look to him for orders and he shall keep or cause to be kept a daily record of the work done.

Force.—The regular force engaged upon the official survey shall consist of the engineer in charge, a draftsman and clerk, and two field parties, each to be composed of a transitman, two tapemen and a rodman. During stormy weather the field parties shall serve in the office. To the above force shall be added such extra assistance as is needed for making and driving stakes, planting monuments and similar work; also extra assistance in the office if it is needed.

Instruments and Material.—All instruments and material used for the official survey shall be of a high grade.

Hours of Service.—All assistants employed upon the official survey shall report for duty at the office at such times as the city engineer shall designate. Failure to do so shall be considered cause for dismissal unless a written excuse has been previously given by the engineer in charge, or under extenuating circumstances. The hours of service required of each assistant shall be nine each working day.

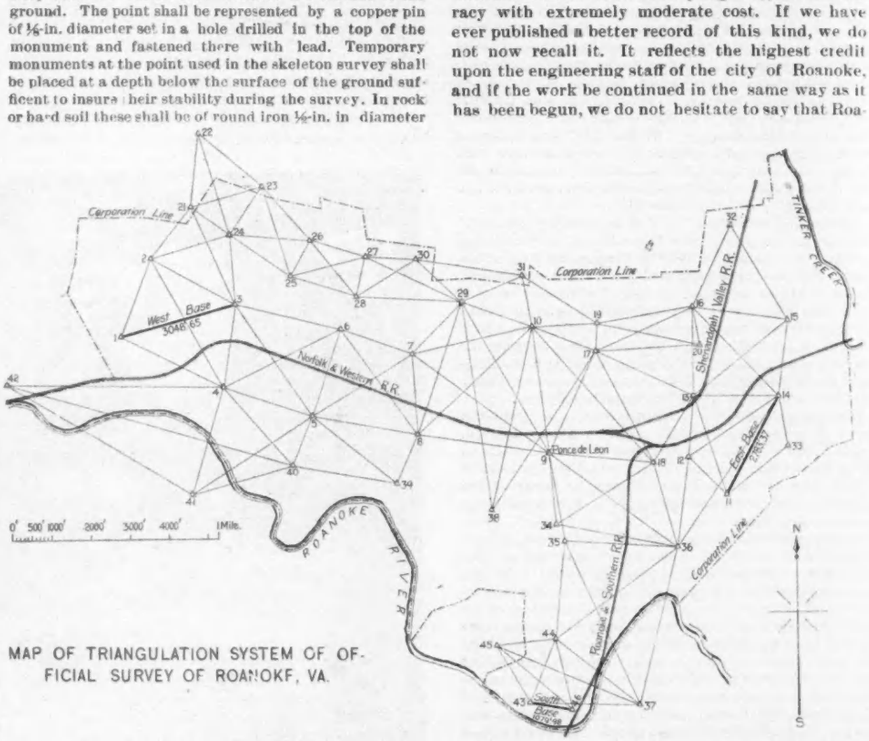
Field Work.—At least two base lines conveniently situated in different parts of the city shall be accurately measured. These lines and a few prominent points within the corporation shall be connected to form an accurate triangulation system. From a point in this system and near the center of the corporation the meridian shall be established by stellar observation, to which the bearing of all lines within the corporation shall thereafter be referred. The boundary line of the corporations and the boundary lines existing at the time the city was incorporated shall be surveyed as far as practicable, and connected with the triangulation system. A skeleton survey shall be made of the whole corporation, consisting of locating points at or near the intersections of streets, points near important objects and points rendered necessary by the topography. This survey will be connected with the triangulation system and its object will be to ascertain the length and bearing of lines connecting the points. The points, together with the triangulation points and corners of the corporation boundary, will be referenced, numbered and recorded. For convenience, these points will thereafter be referred to by number. A detail survey of the whole corporation based upon the skeleton survey shall be made. The object of this survey will be to locate with reference to the skeleton survey, all corners, buildings, street lines fence lines, or any other objects now in existence that can in any way lead to the true location of boundary lines referred to in deeds. When the location of streets and alley lines has been decided, monuments shall be planted throughout the city. Whenever, for lack of sufficient evidence, any street or alley line cannot be definitely established, the same shall be done by an arbitration board consisting of the city engineer, a disinterested person appointed by the Hustings Court and the city solicitor. In some cases these monuments will be at the street corners; in others at street centers; in others, on the curb line or a certain distance from it, the object being to put them where they will be convenient for future use, and at the same time where they are not likely to be disturbed. These will be referenced, numbered and recorded in the same manner as the points of the skeleton survey and triangulation points. They will be referenced by measuring the distance to them from three local objects not in the same straight line. Levels shall be run to establish accurate bench marks throughout the city. Levels shall also be run for the purpose of making profiles over all the streets, alleys and streams within the city. The topography of the city shall be shown with 5-ft. contours. This will complete the field work of the official survey.

Field and Office Notes.—The field and office notes shall be kept in a form prescribed by the city engineer. These notes shall be transferred to books of a form prescribed by him within ten days of the time they are taken. These books shall be properly numbered and indexed and kept in some place of safe deposit. The original notes shall also be preserved.

Monuments.—The monuments at triangulation points shall be of granite, 2 ft. long and 6 ins. square. They shall be buried 1 ft. beneath the surface of the ground. The point shall be represented by a copper pin of ⅛-in. diameter set in a hole drilled in the top of the monument and fastened there with lead. Temporary monuments at the point used in the skeleton survey shall be placed at a depth below the surface of the ground sufficent to insure their stability during the survey. In rock or hard soil these shall be of round iron ½-in. in diameter and 10 ins. long with a ⅛-in. hole drilled in top to represent the point. In soft ground these shall be of sound timber 3 ins. square and not less than 10 ins. long, with the point represented by a copper tack. Permanent monuments at the points established by the survey shall consist of a copper pin 1 in. long and of ⅛-in. diameter set in lead run into rock or metal, of kind, size and position such as to make it durable, not easy of destruction, and solid. The pins must be set a little above the surface of the stone. They will then serve for bench marks. No work likely to destroy any of these monuments shall be begun without a permit from the city engineer, who will have the point carefully referenced and, if destroyed, replaced.

Office Work.—The triangulation survey shall be adjusted by the method of least squares. Errors in the skeleton survey beyond a limit prescribed by the city engineer shall cause a resurvey of the part in question until the error be reduced. Computations connected with the triangulation system, skeleton survey and final location of monuments shall be based upon a system of rectilinear co ordinates, the origin of which shall be assumed to be north and west of the corporation, so that the whole corporation shall lie in the southeast quadrant in order to avoid the confusion of signs sure to result under other conditions. A map on a scale of 100 ft. to an inch shall be made showing the triangulation and skeleton systems for convenience of reference and the making of plans for the prosecution of the survey. A map and tracing on a scale of 20 ft. to an inch shall be made in sections on which will be plotted in conventional colors all the information obtained from the skeleton and detail surveys. Upon this will also be plotted all lines called for in deeds recorded in the clerk's office. With all the evidence in existence thus condensed for a guide, the street and alley lines shall be plotted upon the map in such position as the evidence shall designate. A map on the scale of 400 ft. to an inch shall be made for publication, on which will be shown the street and alley lines as finally located, streams, railroads, 5-ft. contours and other objects of interest. Copies of this map shall be kept for sale at the office of the city engineer at a price designated by the council. Profiles of the streets, alleys and streams shall be plotted and the grades established thereon.

It will be seen at once that this ordinance for an official survey was drawn up by an engineer, who knew what was essential and what was unessential, and not by the city fathers, who honored themselves by passing it without "meddling and muddling." The quality and quantity of the work done to date in the survey, and what it has cost, are lucidly and fully set forth in the following report of the Engineer in Charge, Mr. Geo. P. Wood, dated Dec. 9, 1891, being the final report on the triangulation survey. We commend this report as worthy of the special attention of our readers, in that it records an unusual combination of a very high degree of accuracy with extremely moderate cost. If we have ever published a better record of this kind, we do not now recall it. It reflects the highest credit upon the engineering staff of the city of Roanoke, and if the work be continued in the same way as it has been begun, we do not hesitate to say that Roanoke will have one of the most accurate and complete city maps in existence, while yet among the lowest in cost. The accompanying outline map shows the system of primary triangulation completed.



MAP OF TRIANGULATION SYSTEM OF OFFICIAL SURVEY OF ROANOKE, VA.

To Wm. M. Dunlap, City Engineer.

Dear Sir: The triangulation system, the basis of the Official Survey, is now complete. In order that the record of this survey may be correctly understood in the future, I wish to make the following somewhat detailed report:

The field work was very satisfactorily performed by Messrs. J. R. Downman, J. T. Morgan and their respective parties. The office work was done by Mr. C. H. Rice and assistants. The office record is in itself a witness of ability and painstaking labor.

A study of the ground convinced the writer that the valleys by which the railways have threaded the city made the best location for the main system. From the main system spurs could be thrown out to sufficiently cover the corporation. In the furtherance of this view a chain of quadrilaterals was selected. This chain extends from the Lansdowne tract to the central part of the city, where it branches, one branch going directly south to the river, the other passing through the 3d Ward, crossing the railway east of Woodland Park and ending in the East Side and Belmont tracts. In some cases it was impossible to find stations suitable for use in quadrilaterals on account of trees, buildings or other obstacles. In this emergency triangles were resorted to. There are three triangles in the main system. A spur was selected at the west end, consisting of two triangles and two quadrilaterals. A chain of rather small quadrilaterals and triangles extends from the west end of the main system nearly parallel with the old Lynchburg and Salem Turnpike to a junction with

the main system in the 3d Ward. The entire system is composed of 20 quadrilaterals and 13 triangles, as will be seen on the accompanying map. These are formed by a combination of 46 stations that will hereafter be referred to by number. The main system consists of stations 1 to 18, inclusive, 34 to 37, inclusive, and 43 to 46, inclusive. Station 9 is on the roof of the Hotel Ponce De Leon, and two stations, 13 and 29, were elevated temporarily for purposes of observation. For convenience several of the stations used were located upon high ground a little outside of the corporation. With two exceptions the triangulation monuments consist of a ¼-in. copper wire inserted in the top of a granite block 6 × 6 ins. × 2 ft., and held in place with lead. The exceptions are at 9, where a copper tack in the roof of the Hotel Ponce De Leon, and at 10, where a copper wire inserted in the native rock, designate the points.

Three base lines, situated at the extremities of the main system, have been measured. These have been named with respect to their position—the "south," "east" and "west" bases. Some precautions were taken in the measurement of these lines that may at first thought seem unnecessary. But from the standpoint that all other measurements in this survey, and perhaps of all future surveys within the city limits, will be checked by these measurements, any precaution that will reduce the liability of error is well taken.

Two tapes, 300 ft. long, were used for these measurements, both manufactured by Messrs. Buff & Berger, of Boston, Mass., and each, to all outward appearance, practically like the other. One of these was purchased by the city; the other was kindly loaned by Prof. D. C. Humphreys, of Washington and Lee University. Most of the measurements were made during gentle rain storms, the temperature, which was nearly stationary, being carefully noted. The tapes, during the measurement, were suspended in hooks at intervals of 30 ft. and were subjected to a tension of 16 lbs., applied by motion of a screw and measured with spring balances.

The Washington and Lee tape had been used on the Missouri River survey, and had been compared with various U. S. standards, thereby having its constants well determined. On account of the similarity of the two tapes the constants of the Roanoke tape were assumed to be the same as those of the Washington and Lee tape, an assumption that was proved to be approximately correct by the results. Two measurements of the west base were made with each tape. After being corrected for temperature and reduced to the horizontal plane, the length was as follows:

Mean length of west base by Roanoke Tape, 3,048.639 ft.
" " " " " W. and L. " 3,048.646 "

Four measurements of the east base were made, using the two tapes alternately. On account of delay, changeable weather and darkness, the first and last measurements were thrown out. The result was as follows, after corrections as before:

Length of east base by Roanoke Tape, 2,783.376 ft.
" " " W. and L. " 2,783.372 "

It will be noticed that the discrepancy is here in the opposite direction to the preceding, a fact that goes to show that these errors are due rather to defective manipulation and observation than to a difference in the length of the tapes.

The South base was measured twice with the Roanoke tape. These two measurements gave an identical result to the first three decimal places; each was 1,079.978 ft.

Station 34, situated north of 8th Ave. S. W. and in the line of Commerce St., was selected as the most convenient place to take the observations necessary for the establishment of a true meridian. The latitude of Roanoke was determined from the most accurate map at hand—from a map received from the U. S. Geological Survey—and, roughly, by an observation on the star 51 Cephei; all of which agreed within close limits, so far as its effect upon the determination of the meridian is concerned. The azimuth of the line 34-9 was determined by eight observations, both direct and reverse, upon the star Polaris at eastern elongation. The weighted mean of these eight observations was used. The bearing of this line is found to be N. 5° 11′ 49″ W. The station 34 has been assumed to be 15,000 ft. east and 10,000 ft. south of the origin of co-ordinates.

The instruments used for the measurement of the angles were manufactured by Fauth & Co., of Washington, D. C. The verniers read to 30″ of arc. No appreciable error has been found in the graduations, and they are very well suited for general use in the survey. The angles were measured separately and in pairs by the repeating method. All angles about the stations were repeated not less than five times, direct and reverse. The number of repetitions was determined by the number of times the angle was contained in 360°. In this way 356 angles were measured, that being the number used in the station adjustments.

The method of observation gave rise to certain rigid conditions, to be fulfilled by the angles about the stations. These conditions are, that an angle must be equal to the sum of its parts, and the sum of the angles about the station must equal 360°. The adjustment of the angles to fulfill these conditions was accomplished by the method of least squares. This adjustment gave rise to some very tedious computations. The use of quadrilaterals, of which the system is mainly composed, has given rise to more rigid geometrical conditions than could have been secured by other means. The conditions used in the adjustment, which was also made in accordance with the method of least squares, were that the sum of the angles of each triangle into which a quadrilateral is divided by its diagonals is equal to 180°, and that the sines of all the angles of these same triangles must be proportional to the length of the opposite sides.

The length of sides has been computed by the sine ratio, all computations being carefully checked. The latitude and departure of the various parts of the system have been computed, and from that the rectangular co-ordinates of all the stations. The discrepancies in the system have been adjusted out, and the entire system is now geometrically consistent. A complete record of all adjustments and computations has been kept in a special book for the purpose. This book is kept in a place of safe deposit.

The accuracy of the system has received many very severe tests. Of these, the following are the most important: The length of the east base, as computed from the west base through the main system, varies from its measured length by 0.197 ft., which is to the length of base as one in 14,128. The length of the south base, as computed from the west base, differs from its measured length by 0.012 ft., which is to the length of base as 1 in 89,998. The ratio of these errors to the outside perimeters of the systems through which the computations extend is as 1 to 217,589 and 1 to 4,035,394, respectively. Another very significant check was in the location of station 16. The co-ordinates of this point, as computed in the main system from the west base, differed from its location, as computed from the same base through the north chain, by 0.175 ft. in departure, and by 0.039 ft. in latitude.

An estimate of the cost of this survey, known to be liberal enough to cover every possible item of expense, is as follows.

Field work	$579.48
Office work	386.00
Material, etc	172.52
	$1,138.00

The successful completion of the triangulation system at this time will be very beneficial to the survey. The work can now be checked as it proceeds, and the fact that it will be checked by comparison with an accurate triangulation system cannot be too highly appreciated.

Believing this work will meet with your approval, this report is respectfully submitted.

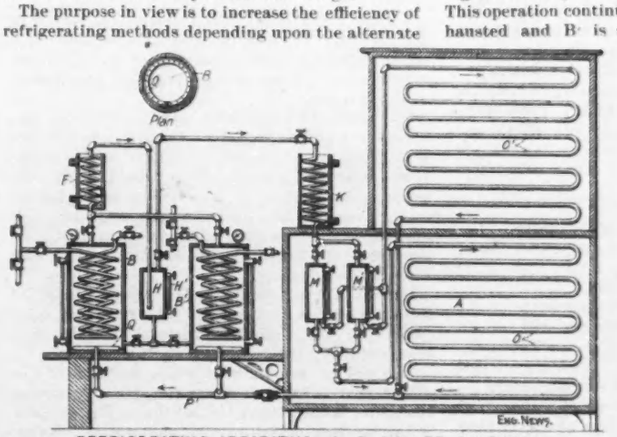
Geo. P. Wood, Engineer in Charge.

The area covered by this survey is approximately 6,000 acres, making the total cost of this triangulation less than 20 cts. per acre.

A NEW REFRIGERATING APPARATUS.

The demand for a simple, cheap and portable refrigerating apparatus has been felt for a long time and in many countries, and in the device described below these conditions seem to be most ingeniously and fully met, according to severe and practical tests of which we have personal knowledge.

The purpose in view is to increase the efficiency of refrigerating methods depending upon the alternate vaporization and liquefaction of volatile liquids, the latter in a gaseous form being conducted through closed pipes placed in a chest for the purpose of cooling any object placed in this refrigerating chest. To attain the end in view the device to be described is so arranged as to be used either in the compressing or the absorbing system of refrigeration, and any failure in the supply of refrigerating vapor is automatically corrected by the action of overheated vapor in devices expansible by heat.



REFRIGERATING APPARATUS: C. F. MILLER, INVENTOR.

Several patents have been issued to the inventors, but the cut illustrates the latest improvement, under date of Nov. 10, 1891. Referring to the cut, this apparatus may be described as follows: Connected with the refrigerating chest or room A are the two generators, B B′, which contain liquid or other absorbent of ammonia gas or other volatile refrigerant. Within each generator is a double spiral coil, connected respectively with a source of steam supply and a cold water supply, in such manner that each generator may be alternately heated or cooled at will. Pressure gages and a vertical tube for indicating the height of the liquid in the generator are provided as shown.

From the generator B a tube leads to a coil inside the cooling receptacle F placed above it. This cooler is provided with cold water inlet and outlet, so arranged that the flow of water may be reversed. The second generator B′ is connected by a pipe with this same cooling chamber. While by a proper manipulation of the valves both generators may be allowed to supply the coil simultaneously, in practice one generator will generally be used for giving off the ammonia gas to the cooler while the other generator is absorbing gas preparatory to such service in its turn.

From the top of the coil in the chamber F a bent pipe passes down to a drying or separating tank H, which has a water outlet tube communicating by branch tubes, controlled by valves, with the bottoms of the two generators. From the top of this drying tank another pipe leads the ammonia gas or other material used to the upper end of a coil in the condenser K provided like F with cold water inlet and outlet pipes. In the bottom of K is a pipe leading down into the refrigerating chest or room A, and communicating by a branch pipe with two liquid storage tanks M and M′. From the bottom of these tanks pipes, controlled by hand valves, connect with the refrigerating coils O and O′, which latter have an outlet pipe provided with a check valve, passing back to the two generators, as shown.

The operation of the apparatus is as follows:—Hot water or steam is admitted to the coil in the generator B, and cold water is turned on to the generator coil in B′, the former alone being in communication with the cooler F. The gas then passes from B into F and is cooled sufficiently to condense the steam, the water passing down the curved pipe to the separating tank H, whence it flows back to the generators. The pure anhydrous ammonia from the tank H passes to the coil in the condenser K, where it liquefies and descends to the storage tanks M, M′ and on into the refrigerating coils O, O′. The check valve in the return pipe P prevents any of the gas which remains in the generator B′ from being absorbed by the water which is in the generator. This operation continues until the generator B is exhausted and B′ is sufficiently charged, when the water and steam supplies are reversed and the operation continued through the second generator while the first is being recharged. The gas is supplied to the generators through fine holes in a circular pipe in the bottom and the process of absorption is thus hastened.

In the original patent of June 9, 1891, three generating cylinders are each heated by a lamp or other heating apparatus placed under the cylinders. The generators are surrounded by water jackets, with inlet and outlet pipes, valves, etc. Above two of the larger cylinders are steam condensing tanks with coils and water inlet and outlet, the water of condensation running back into the cylinder. From the tops of three condensing tanks a horizontal pipe runs to another condensing cylinder, with a pressure gage attached, which converts the gas entering into a liquid. This liquid is then led to a storage tank and into the refrigerating pipes as before.

A valve at the base of the storage tank regulates the flow of liquid into the cooling coils. This valve is made automatic in its action by an alcohol tube

in the form of a worm, which is operated upon by the weakening and consequent overheating of the refrigerant. This coil is placed in a cylinder where the ammoniacal gas has access to it; one end of the coil is closed, but the other end acts upon a piston, which is made to open or close the first named regulating valve. To this refrigerator a pump is also attached, with an external tank, by means of which the gas is cooled in a separate condenser and an external tank, and is liquified in the inside storage tank chiefly by the pressure resulting from the action of the pump. The automatic regulating valve operates as before and the circulation is made complete. This pump is used in case of repairs to both main generators, or when it is deemed best not to use them for a short time. The third generating cylinder mentioned is chiefly used to compensate for weakness of the gas due to leakage.

These machines are the inventions of Mr. Charles F. Miller, of Lancaster City, Pa., and the apparatus has been practically and severely tested in that city and at other points for over one year. A 4-ton plant is in operation in the cold storage room of Mr. Wm. Fuhrman, of Lancaster, Pa., and fresh beef has been kept there for 4 months, with its quality said to be improved by the dry, cold atmosphere in which it has hung. Mr. Fuhrman says that as an average for 4 months his expense for fuel has been $0.45 per day, and the operation was so simple that his ordinary workmen attended to it. He used 4 tons of ice per day previously, and then did not secure perfectly dry air in his cooling room, which is 28 × 22 ft. by 12 ft. high. As he has a steam plant to run other machinery, he uses steam to generate the gas from ammonia. The steam is turned on for 1½ hours in the morning, and the evening and during the rest of the 24 hours the operation is perfectly automatic.

The claim is made that the finest ice can be turned out with this apparatus at an expense for fuel of 25 cts. per ton, and 3 to 4 hours' labor in each 24 hours. The Automatic Refrigerator & Ice Machine Co., with its main office in Lancaster, Pa., now makes these machines in all sizes, from those adapted to household purposes up to 50 ton machines, and we must refer our readers to this company for further details. The company has already erected several large plants in various States which are working most satisfactorily.

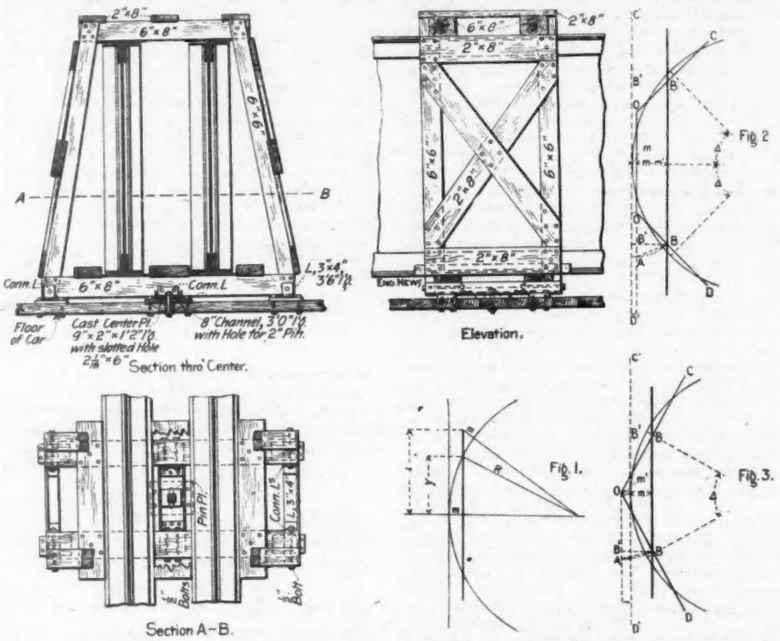
LOADING LONG GIRDERS ON CARS.

We are indebted to the courtesy of Mr. F. H. Kindl, Chief Engineer of Carnegie, Phipps & Co., for the following description of the most approved method of loading long girders on cars, together with the calculations used in arriving at conclusions, Mr. Kindl says:

We will assume that the cars are blocked as far apart as possible so that there can be no slip on a straight track, and we have only to consider the position and motion of the freight when rounding a curve, which, for simplification we will call a girder. From calculations we deduce that the least deviation of the end of the center of girder from the center line of track is obtained when the girder is supported at two points at a distance of $\frac{L}{1.4}$ from center of girder, in which L is one-half the length of the girder. The maximum deviation at the ends and center line of the girder when so supported is $\frac{L^2}{4R}$ in which R is the radius of the curve. This deviation of the girder is from the center line of the curve and will have to be modified if desired from the center line of the car, as really occurs in practice. This being a small amount can for practical purposes be neglected.

From calculations of longitudinal slip the exact amount can be obtained when the girder is supported as per previous formula, hence the bracing holding the girder must be so constructed as not to be deranged by this. It is also evident that when the girder is supported on one car only, and the front and rear cars used as idlers, no longitudinal slip can take place. In this case, however, the lateral deviation will be twice as great as when supported at two points.

As the longitudinal slip is very apt to derange the bracing holding the girder in position on the car unless provision is made, it would seem that a girder supported on one car, with the two end cars as idlers, would be the most efficient, providing the deviation would not exceed the limit; that is, that the ends of the girder do not interfere with the passage of cars on two tracks, the limit of which can be fixed for every railway. When this limit is exceeded, supports at two points must be provided for and the longitudinal slip taken care of. This can be accomplished by supporting both ends of the girder on a frame fastened thoroughly, by means of bolts or otherwise, to the girder. This frame should be so constructed on the car as to be able to revolve about a center pin, which center pin should have a sufficient longitudinal freedom on a center line of each car equal to about one-half the slip, or, better, having one frame to revolve about its center, and making allowance for all the slip on the other car; thus the frame bracing the girder will not be subject to any derangement. In other words, one support is equivalent to a double bolster, while the other has besides



MOVABLE BOLSTER FRAME FOR SUPPORTING LONG GIRDERS ON CARS.

longitudinal freedom, which can be readily calculated by the formula for the longitudinal slip of the girder.

The cut given shows such a frame with fastening for girders. The diagram gives an example of a girder rounding the sharpest yard curve of the Pennsylvania R. R., which gives a practical application of the formulæ.

The method of supporting long girders on one car, although avoiding the longitudinal slip, is not only objectionable on account of always having to use three cars when sometimes two would answer the purpose, but also that the weight is carried by a single car, and that the ends, not being supported, are subject to vibrations, which, in connection with the centrifugal force, might disturb the bracing and cause serious damage.

Mr. Kindl then submits the following formulæ for determining the best method of supporting long girders on cars, so that their lateral deviation may be as small as possible when rounding curves:

This will be accomplished when the ends of the girder deviate from the curve the same amount as the center of the girder. Referring to Fig. 1: Let l = half the length of the girder, and m the deviation of the center line of the girder from the center line of the curve at the center and ends of the girder.

Then to find y, the distance from the center of the girder at which the girder should be supported so as to give the least lateral deviation.

$$y^2 = R^2 - (R-m)^2 = 2Rm - m \qquad (1)$$

and $$l^2 = (R+m)^2 - (R-m)^2 = 4Rm \text{ or } R = \frac{l^2}{4m} \qquad (2)$$

Substituting this value of R in equation (1)

$$y^2 = \frac{l^2}{2} - m^2, \text{ or } y = \sqrt{\left\{\frac{l^2}{2} - m^2\right\}} \qquad (3)$$

But m being small compared to l may be practically disregarded, or $y = l \div 1.41$.

From equation (2) the value of m can be found, or

$$m = \frac{l^2}{4R}$$

If gondola cars with fixed sides are used it is desirable to know the deviation from the center line of the cars instead of from the center line of the curve. It must be remembered that the center line of the cars only coincides with the center line of the curve at the king bolts of the trucks.

The greatest deviation of the center line of the cars from the center line of the curve will be at the middle or ends of the cars, which owing to the position of the trucks is practically equal; this amount m' will be equal to the middle ordinate to the curve from a chord of the curve = the distance between the trucks = 24 ft. for a 36 ft. car. Then $m' = R - \sqrt{[(R + \frac{1}{8}C)(R - \frac{1}{8}C)]}$, C being the chord of the curve.

When three cars are used (see Fig. 2), with the middle one an idler and the girder supported according to the above rules, the deviation of the center line of the girder from the center line of the middle car will be equal to $m - m'$; and when two cars are used (see Fig. 3) the deviation of the girder from the coupling of the two cars will be $m + m'$. In both cases the ends of the girder will deviate from the center line of the cars an amount ranging between $m - m'$ and $m + m'$, according to the position of the points of supports.

To find the amount of longitudinal slip of the girder on the car at each point of support (see Figs. 2 and 3), we will first assume that three cars are used (Fig. 2). O is the point of coupling of the cars, and $C\,O\,O\,D$ the positions of the center of the cars on a curve. The ends of the cars C and D will revolve to C' and D' when the cars return to the tangent, and the center line of the cars will also move toward the tangent an amount equal to m'. $B\,B$ are the points of support of the girder on a curve; these will move to $B'\,B'$ when the cars return to the tangent, while the point B on the car will move to A, and $A\,B'$ will be the amount of the longitudinal slip, since $O\,O$, $O\,D$ are parallel to tangents of the curve of a length equal to half the length of the car:

Then $L\,A\,O\,B = L$ subtended at the center of the curve by these tangents $= \Delta$ and $L\,A\,B\,B' = L\,O\,A\,B - L\,O\,B\,B' = \frac{1}{2}(180° - \Delta) - (90° - \Delta) = \frac{1}{2}\Delta$. Then $A\,B' = (m - m')\tan \frac{1}{2}\Delta = (m - m')\frac{T}{R}$ where T is the tangent = half car length. In Fig. 3 the $L\,A\,O\,B$ is $= \frac{1}{2}\Delta$ and $A\,B'$ reduces to $(m + m')\tan \frac{1}{2}\Delta = (m + m')\frac{T}{R + \sqrt{R^2 + T^2}}$

The following example can be given: A girder 90 ft. long is loaded on three cars, the middle one being an idler. Required (1) the positions of the points of support to give the least lateral deviation of the girder from the curve, also the amount of this deviation; (2) the amount of the lateral deviation from the center line of the cars; (3) the amount of longitudinal slip of the girder on the car, when passing round a curve of 37° 41', equivalent to a radius of 154.4 ft.

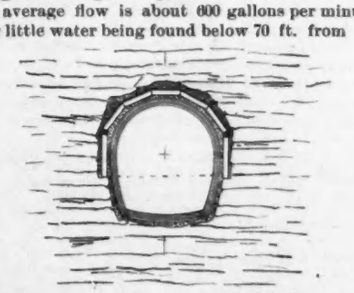
This curve is taken as being the sharpest yard curve used by the P. R. R. (1) m = the deviation from the center line of curve $= \frac{l^2}{4R} = \frac{45^2}{617.6} = 3.28$ ft. y = the distance of support from center of girder $= \sqrt{\left\{\frac{l^2}{2} - m^2\right\}} = \sqrt{1001.7} = 31.65$ ft. or $y = \frac{l}{1.41} = 31.92$ ft., which is close enough for practical purposes. Consequently the girder should be supported about 31 ft. 9 in. from its center to give the least lateral deviation from the curve, which will be equal to about 3 ft. 3 in. at the middle and ends of the girder in this case.

(2) m' the deviation of center line of cars from that of curve $= R - \sqrt{\{(R + \frac{1}{2}C)(R - \frac{1}{2}C)\}}$; C = distance between trucks = 24 ft. for a 36-ft. car. m will reduce to 0.47 ft. or nearly 6 ins. The deviation of the middle of the girder from the center line of the idler is then $m - m'$ or about 2 ft. 9 ins.; and the deviation of the ends of the girder from the center line of the end cars will lie between 2 ft. 9 ins. and 3 ft. 9 ins. in this case the value will be very close to 3 ft. 3 ins.

(3) The longitudinal slip of the girder on the car $= (m - m')\frac{T}{R} = \frac{2.81 \times 18}{154.4} = .328$ ft. or nearly 4 ins. at each point of support.

PROGRESS ON NIAGARA FALLS TUNNEL.

The contract for the construction of the Niagara Falls Power Company's tunnel was let to Rogers & Clement and contract executed on Sept. 12, 1890, and the work has been under the immediate charge of Mr. Albert H. Porter, Engineer, and Mr. Geo. D. Burbank, Consulting Resident Engineer. The work now under contract covers a tunnel 6,700 ft. long, and three shafts in connection therewith. Shaft No. 1 is 260 ft. and shaft No. 2 196 ft. in depth. They were commenced in October, 1890, and completed in April, 1891. Much difficulty was experienced owing to the great quantity of water encountered, a full account of which will be given in a later issue. The maximum flow of water in Shaft No. 1 was found at a depth of 105 ft. below the surface, the average flow being about 800 gallons per minute. In Shaft No. 2 the average flow is about 600 gallons per minute, very little water being found below 70 ft. from the surface. At times the flow exceeds these amounts.



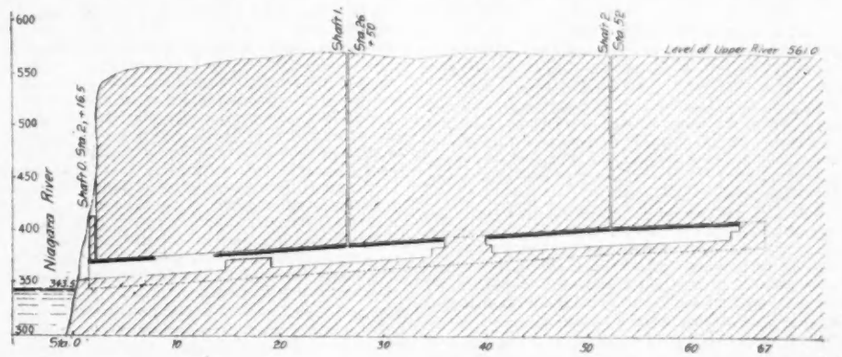
Cross Section of Main Tunnel (21 x 19 ft.)

Shaft Zero, or the portal shaft, was commenced in February, 1891, and sunk rapidly without any difficulty. The work of fitting up the shafts and getting under way was tedious and expensive, owing to the great amount of water. Some headway was made at the portal and at Shaft 2 between April and June, during which time several changes were made in the original plans. Final plans were adopted June 15th, after it was found necessary to line the tunnel throughout with brick, and to hold up the ground with timber in advance of the brick work. The new plans lowered the grade at the portal and Shaft No. 1 below the level of the tunnel driven, and required the enlargement of the section driven from Shaft No. 2. Owing to the dangerous character of the rock, the work proceeded very slowly at all points until July 18, from which date progress on the new plans has been recorded.

The headings between portal end and west end of Shaft No. 1 were broken Dec. 24. The maximum progress, 338 ft., was made in the portal heading from Nov. 28 to Dec. 24, 26½ days, which we think breaks the record of tunnel driving. About two-thirds of the whole section was taken out, an upper heading of 9 ft. × 24 ft. and one bench 8 ft. × 24 ft., equaling 13.5 cu. yds., leaving a second or lower bench to be taken out as the brick work advanced. The method adopted for driving this tunnel was the "American center cut" system, four drills being used in the portal heading and two in the other headings. The character of the rock in portal and part of west end of Shaft No. 1 is hard limestone; East No. 1 and both headings of Shaft No. 2 were in Utica shale, and, with the exception of 750 ft. in the portal end, it was necessary to put in timber close up to the heading. The benches were taken up as fast as the timber work would permit. The rapid progress made is attributed to the application of the plant and the superior ability of the men employed.

The plant located at the central or plant station at Shaft No. 2 consists of eight 100-HP. boilers made by the Porter Mfg. Co.; three 18 × 30 in. Rand duplex air compressors; a Thomson-Houston electric light plant, and a sawmill with a capacity of 20,000 feet per day. The shafts are fitted with Otis automatic hoisting engines, with double cages at Shafts 1 and 2 and single cage at Shaft Zero. The drills used were 25 Little Giants (No. 3¼) made by the Rand Drill Company, and three Sergeant drills; the latter were used in the heading West No. 2.

The pumping plant at Shaft No. 2 consists of four No. 7 and one No. 9 Cameron pumps. At Shaft No. 1, two No. 7 and two No. 9 Camerons and three Snow pumps, equal to No. 7 Camerons, are employed. An auxiliary boiler plant consisting of two 60-HP. boilers is located at Shaft No. 1, and one 75-HP. boiler at Shaft Zero, to furnish steam for the pumps and hoisters. For explosives a special high Rackarock was used in sinking the shafts through the wet, hard rock, and Forcite powder was employed in driving the tunnel headings.



PROFILE OF NIAGARA FALLS TUNNEL TO DEC. 24, 1891. (Heavy Black Lines Show Timbered Section.)

Weekly Progress in Lineal Feet at Niagara Falls Tunnel. Rogers & Clement, Contractors.

	Total progress to July 18.	July 25.	Aug. 1.	8.	15.	22.	29.	Sept. 5.	12.	19.	26.	Oct. 3.	10.	17.	24.	31.	Nov. 7.	14.	21.	28.	Dec. 5.	12.	19.	24.	Total.
Portal	210	38	42	52	44	46	5	40	71	71	0	61	68	76	55	78	68	82	88	63	82	90	94	72	1,636
Heading No. 1, W.	59	12	9	0	0	2	2	35	15	39	42	41	40	54	29	45	48	58	48	49	44	54	52	46	844
" " 1, E.	50	14	6	0	13	10	11	33	30	37	41	30	33	42	41	60	43	71	62	42	61	70	63	48	910
" " 2, W.	95	35	41	56	30	34	33	61	43	63	58	39	29	48	48	45	48	60	60	51	47	56	44	36	1,164
" " 2, E.	123	39	39	59	42	16	34	37	44	51	50	54	33	49	52	35	54	58	62	57	57	61	65	45	1,194
	537	138	131	13.	129	108	174	206	203	261	191	225	200	269	225	263	261	329	320	262	291	331	318	247	5,750

The block system is to be put in operation over the whole main line of the New York Central & Hudson River Railroad, according to a letter written by President Depew to the Board of Railroad Commissioners. He states that contracts have been let to the Johnson Railroad Signal Co. for the Sykes block signals from Yonkers to Oscawana, about 22 miles, the blocks averaging 1¼ miles in length. From Oscawana to Peekskill, 6 miles, the Hall block system has been in use for over a year, the signals being 3,000 ft. apart. (See description in Engineering News, Sept. 13, 20, 1890.) Contracts have also been let to the Johnson Co. for putting in the Sykes system from Peekskill to Poughkeepsie, 31 miles, the blocks averaging 2¼ miles in length. From Poughkeepsie to Albany, bids are being received for the Sykes system, the specifications calling for 40 blocks in a distance of 69 miles. The work is expected to be completed as far as Peekskill within six weeks, and between Albany and Peekskill it will be completed as fast as the contractors can perform it. Mr. Depew continues as follows:

We have decided to extend a block system from Albany, over the line of our road, to Buffalo. We have not yet determined what system it is best to put in between Albany and Buffalo. In this connection we are considering the merits of the Sykes, the Westinghouse pneumatic, the Hall and one which is in use on the Boston & Albany Road. The Westinghouse pneumatic is in operation on the Harlem Division, between Woodlawn and Mott Haven, and doing good work, and has already been carefully examined by your board. Our officers believe that this system, used as an auxiliary with the Sykes block at stations only, would meet all the requirements between Buffalo and Albany.

The Long Island R. R. has just put block signals in operation between Long Island City and Jamaica, a distance of 9 miles. The company is reported as intending to extend the system over all its double track lines, the work to be completed before June 1.

The New York, Lake Erie & Western now has block signals over its entire main line, except a gap of 40 miles on the Delaware Division, and the equipment of this is expected to be completed within 10 days.

The Carpenter Steel Works at Reading, Pa., which were totally destroyed by fire on the night of Dec. 26, are to be immediately rebuilt, and will be enlarged to double their former capacity. The specialty of the works is the highest grade of tool steel, and their Government contracts on hand for armor-piercing projectiles, etc., amount to about $230,000.

The barbette plates for the new cruiser "Monterey," which is now nearly completed at the Union Iron Works San Francisco, have been forged, bent and cut to rough lengths. A ballistic test of samples of the plates will soon be made at the Indian Head proving grounds. If it results satisfactorily, the last of the plates should be shipped to San Francisco by Feb. 1. The 12-in. rifle for the "Monterey" is to be shipped from Washington in a few days the Pennsylvania Railroad having furnished a special car for its transportation.

PERSONALS.

Mr. C. C. Smith has been appointed Assistant General Manager of the Rio Grande Western Ry.

Mr. Stephen S. Cobbe, First Railway Commissioner of Michigan, under the law of 1873, died at Kalamazoo, Mich., Dec. 30.

Mr. J. D. Williams has been appointed Chief Engineer of the Cincinnati, Jackson & Mackinaw R. R., with office at Van Wert, O.

Mr. W. J. Dale, Jr., of Boston, Mass., has been appointed a member of the Massachusetts Board of Railway Commissioners; vice Mr. E. K. Kinsley, deceased.

Mr. Stuart Knott has been appointed First Vice-Presi-

dent of the Louisville & Nashville R.R., and Mr. V. Vanderberg has been appointed Traffic Manager in his place.

Mr. John F. Wallace, M. Am. Soc. C. E., Constructing Engineer for the Illinois Central Railway, has been nominated for President of the Western Society of Engineers.

Mr. M. Riney, of Chicago, has been appointed by A. Gottlieb & Co. to superintend the erection of the dome of the Administration Building at the World's Columbian Exposition.

Mr. F. P. Lord, Assistant Engineer of Motive Power on the Pittsburg, Fort Wayne & Chicago Ry., has been appointed Superintendent of Motive Power of the Cleveland, Cincinnati, Chicago & St. Louis Ry.

Mr. P. P. Wright, General Superintendent of the Lake Shore & Michigan Southern Ry. has been appointed Assistant General Manager, and Mr. W. H. Canniff has been appointed General Superintendent.

Mr. John K. Case, an old locomotive engineer and master mechanic, died in Vincennes, Ind., Dec 27. He was the first master mechanic of the Ohio & Mississippi R. R. at Vincennes and is said to have run the first locomotive west of the Allegheny Mountains.

Mr. J. S. Ford, lately of New York, is now First Assistant Engineer on the location and construction of the railway now being built from Carthagena to the Magdalena River, Republic of Colombia, S. A. The Carthagena Terminal & Improvement Co., of Boston, Mass., is at the head of the enterprise.

Interstate Commerce Commissioners have been appointed as follows: Mr. J. W. McDill, of Iowa (at one time a member of the Iowa Board of Railroad Commissioners), to succeed Judge Cooley, who resigned last spring; Mr. W. M. Lindsey, of Kentucky, in place of Mr. W. L. Bragg, who died last year, and Mr. W. R. Morrison of Illinois, has been reappointed.

Mr. F. W. Mowbray, late Architect for the Louisville & Nashville R. R. Co., has opened an office at 258 West Main St., Louisville, Ky., for general practice, and will make railway buildings a specialty. He was one of the architects of the Centennial Exposition, and has had 20 years' experience. His latest work completed is the Union Station at Louisville, Ky., illustrated and described in our issue of July 25, 1891.

Major H. W. Clarke, M. Am. Soc. C. E., who, over a year ago, under orders from his physician, resigned the office of City Engineer of Syracuse, is still suffering from the disability which induced his resignation. Major Clarke effected very considerable reforms in the department, and still others have been introduced and carried out by his successor, Mr. Harry C. Allen, Assoc. M. Am. Soc. C. E., who was formerly his deputy.

Mr. Roswell B. Mason, at one time Mayor of Chicago, died in that city on Jan. 2. Mr. Mason was born in New Hartford, N. Y., in 1805, and was one of the engineers on the Erie and Schuylkill canals, and from 1825 to 1831 was superintendent of the Morris Canal, in New Jersey. He was afterward connected with the construction of the Housatonic, the New York & New Haven and the Vermont Valley railways. In 1851 he went to Illinois to build the Illinois Central R. R. and was later connected with the construction of other railways and the improvements of the Illinois and Michigan Canal. He was Mayor of Chicago during the great fire and his personal efforts at that time are historic.

Prof. Joseph Henry's claim to the discovery of magneto-electricity is to be made clear in a series of articles to be published in "The Electrical Engineer" for 1892, by Miss Mary A. Henry, of Washington, D. C. These letters will be given with notes by Mr. Franklin Leonard Pope, and are practically brought out by the fact that at the late Frankfort Electrical Congress, when the name "Henry" was suggested for an important new unit, it failed of adoption because many of the European delegates said they had never heard of Henry. The distinguished scientific work of Prof. Henry, and his claim to honor for original discoveries have been neglected for some years past, and it is time that the scientific world of today was reminded of the great value of his investigations.

Mr. Samuel B. Reed, M. Am. Soc. C. E., of Joliet, Ill., died Dec. 26, 1891, at Pasedena, Cal., where he was spending the winter in search of health. He was engineer of the first railway connecting Chicago with the East. He also built and projected the Chicago, Rock Island & Pacific R. R., the first bridge across the Mississippi at Davenport, and the Washington branch of the Burlington & Missouri River R. R., the first road reaching the Missouri River. During the building of the Union Pacific Mr. Reed was superintendent of construction and did the most rapid work then on record in railway construction. After completing the Union Pacific he had charge of construction of the Illinois Central from Memphis to New Orleans. Later he was receiver of the Chicago, Pekin & Southwestern, at present the Atchison, Topeka & Santa Fé R. R. and California Railway. He is among the last of the eminent railway men of a quarter of a century ago who were active in the building of the Union Pacific Railroad. Among those remaining are Sidney Dillon and Gen. G. M. Dodge, who was chief engineer of the road. Mr. Reed was 73 years old.

Gen. Montgomery C. Meigs, U. S. Engineer Corps, died Jan. 2, at Washington, D. C. He was born in Augusta, Ga., in 1816, and was educated at the University of Pennsylvania, which he left to enter the U. S. Military Academy, from which he was graduated in 1836. His first appointment was in the artillery, but after a short time he was transferred to the Engineer Corps. While a young lieutenant of engineers, he was occupied in the building of Fort Delaware, in the improvement of the harbors of the Delaware and other rivers and bays along the Atlantic coast, and in the superintendence of the work of construction of Forts Wayne, Porter, Niagara and Ontario. In 1852 he was assigned to the Engineer Bureau in Washington, and was assigned to the duty of designing and superintending the construction of the Potomac aqueduct, including the great Cabin John masonry bridge, with arch of 220 ft. span, the longest stone arch span in the world. Subsequently he was placed in charge of the construction of the new wings and iron dome of the extension of the Capitol building. He served with distinction in the war, and in 1861 was appointed Quartermaster General of the U. S. Army, which position he held until his retirement in 1882. After the war he returned to Washington, but spent considerable time in the Southwest and on the Pacific Coast in surveying routes for railways. In 1875-6 he was sent to Europe to study the government of European armies and was then made a member of the commission to reform and reorganize the army. In the latter years of his active career in the army he was engaged on the plans under which the new State, War and Navy Department Building and the National Museum were constructed. After retirement from the army he was the architect of the Pension Building, was a regent of the Smithsonian Institution and a member of various scientific societies.

NEW PUBLICATIONS.

JANUARY MAGAZINES.—The "Popular Science Monthly" contains several articles likely to interest engineers, but the one of most direct interest is by M. Trouvé on "The Aviator Flying Machine," in which the author records the results of his own experiments. He states it to be determined by himself and others that the pigeon does work (*i.e.*, effective work) at the rate of a horse power per 27½ lbs. (12.5 kilos.) of weight, and that the actual exertion of energy (much of it being assumed to be lost on what we think very doubtful evidence) is at the rate of a horse power per 7.7 lbs. (3.5 kilos.). He declares that a motor only can be constructed within this weight; but that with the generator and propeller this weight is much exceeded. He then goes on to detail some very interesting and novel experiments by which imitation birds, charged with 12 detonating mixtures of oxygen and hydrogen in a 12-chambered "revolver," so as to give 12 successive flappings of the wings, were caused to fly 250 to 275 ft. while steadily rising, thereafter sailing on for a considerable distance further by parachute action of the wings. While it is not at all likely that the successful flying machine will imitate the wing action of the bird, this experiment is one of great interest, as well as novelty. The frontispiece to this number is a very fine portrait of Elias Loomis, whose textbooks have assisted many an engineer to lay the foundation for his mathematical attainments. A brief sketch of Prof. Loomis' life accompanies the article.

In the "North American Review," General Superintendent Voorhees, of the New York Central & Hudson River R. R., writes on fast runs in railway service with especial reference to the qualities necessary in the locomotive engineer. As an instance of the nervous strain under which engineers often work, and the fact that a single accident will sometimes give the nervous system a permanent shock, he tells the story of a young engineer who stood by his locomotive in a butting collision and sustained no injury but a dislocated shoulder. The collision occurred at night on a very crooked piece of road. When the engineer reported for duty again he was put back on his former train and appeared to be quite well and as fit as ever for duty. The train started, and all went well during daylight. The return trip was made at night. As the train approached the crooked piece of road, the fireman noticed that the engineer seemed to grow white and nervous and involuntarily to shut off steam. The train drew nearer and nearer the scene of the accident, and the engineer grew more and more nervous. Finally when the exact spot was reached, he fell over. He had fainted. His career on the footboard was at an end. A paper on "Wages in Mexico," by M. Romero, the Mexican minister to the United States, gives some interesting figures of the cost of labor and of many commodities in that country, and evidences the need of capital and enterprise to develop its natural resources.

In "The Forum" Mr. Courtenay De Kalb, an American mining engineer who has spent some years in Brazil, discusses the late crisis in that country and its causes, and concludes that Brazil can never become a united nation until ample railway communication is furnished between her several provinces. Enough money has been spent in railway construction, but the lines have all been local and a national highway is still her greatest need.

"The Century" has an article of great historical interest on "Custer's Last Battle," written by Capt. E. S. Godfrey, one of his troop commanders; with an appended discussion by Gen. Fry. There is a quite general impression that the fatal massacre on the Little Big Horn in 1876 was due to Gen. Custer's rashness, in attacking an enemy of vastly superior numbers. The dead, like the absent, are always wrong, and certain living officers have had strong reasons for insisting that it would have been foolhardy rashness to do any fighting on that occasion. The testimony collected by Capt. Godfrey shows, however, that Custer's movement was strictly in accordance with his written orders, and was upon the very point of success, the Indians having begun a movement of retreat, when the sudden retreat of Major Reno before he had lost a man caused them to change their mind, recover confidence, and unite their entire force upon Custer. Had the six companies under Major Reno pressed the enemy, as did Custer's five companies, Capt. Godfrey's account seems to clearly indicate that, if the Indians had not sooner abandoned all resistance a junction might have been effected in the heart of the Indian camp and the Indians defeated. Fortunately the march of civilization has all but done away with the risk of any future repetition of this terrible affair.

In "Harper's" Julian Ralph has two articles worthy of note here, one describing "Our Exposition at Chicago," and the other a very well written paper on British Columbia and its wealth of natural resources, which have as yet been so little developed.

U. S. GEOLOGICAL SURVEY. Tenth Annual Report, 1888-89, to the Secretary of the Interior. Part I. Geology. By J. W. Powell, Director. 4to pp., 774; 98 plates and maps and 69 figures.

The eleventh annual report is now in press. The present volume contains the full reports of Director Powell, and in this connection is given a valuable report on nomenclature and conventional symbols for geologic maps and sections, with colored illustrative plates. The administration reports follow and then come special reports on the following subjects: The fresh water morasses of the United States, including a handsomely illustrated and most interesting report on the Dismal Swamp, reports on the Penokee iron bearing series of Michigan and Wisconsin, and on the fauna of the Lower Cambrian zone. The report on fresh water morasses estimates that there are from 105,210 to 131,200 sq. miles of inundated land in the United States. The State of Florida alone has 28,000 acres of such land, and Louisiana comes next with 14 000 and Arkansas with 10,000 sq. miles. It is probable, however, that not more than 10 000 sq. miles of this inundated territory can be reclaimed by ordinary engineering devices.

REPORT OF THE COMMISSIONERS OF THE (N. Y.) STATE METEOROLOGICAL BUREAU AND WEATHER SERVICE. Second Annual Report for the year 1890. Prof. E. A. Fuertes, Director. Pub. Doc., 8vo., pp. 416. With numerous meteorological maps and tables.

The commissioners very properly apologize for the long delay in the publication of the report, which does them great credit, however. It would be difficult to see how more complete information as to the weather of a state could be given, and a good part of the report is also devoted to a summary of the leading crops, and of the effect of the season's weather thereon. We have from time to time noted in these columns the good work which is being done by this Commission in the way of crop bulletins and the like, in addition to its regular work, which is very faithfully and skillfully carried on.

REPORT OF THE BOARD OF RAPID TRANSIT COMMISSIONERS, In and for the city of New York to the Common Council, With the Documents, Maps and Plans Attached Thereto, Oct. 20, 1891. William Steinway, John H. Starin, Samuel Spencer, John H. Inman, Eugene L. Bushe, Commissioners. 8vo., paper, pp. 128.

This is the official report of the New York City Rapid Transit Commission, with the full reports of its engineers Messrs. Wm. E. Worthen and W. B. Parsons, and of its consulting engineers, Messrs. Chanute, Wilson, Cooper and Bogart. The drawings and maps accompanying the reports of the engineers and the final report of the commission are also given. Practically all the matter of engineering interest in the volume has been published in "Engineering News" of June 6, July 18, Oct. 10, Oct. 17, Oct. 24, Oct. 31, 1891.

OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS.—Transactions of the Twelfth Annual Meeting, January, 1891. E. D. Wileman, Secretary, Massillon, O.

This volume was noticed in our issue of Dec. 19, 1891, but two features not there referred to were a list of surveyors and engineers in the state and an index to back numbers.

SOCIETY PROCEEDINGS.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—The regular meeting was held Jan. 6, Mr. A. Fteley, Vice-President, in the chair. The Secretary announced the deaths of Mr. Samuel B. Reed and Mr. J. R. Wardlaw.

In a brief discussion on the paper by Mr. Waddell on "Disputed Points in Bridge Designing" (Eng. News, Dec. 12 and 19, 1891), Mr. Harding spoke in favor of the use of

the pony truss under certain conditions up to lengths of 90 ft. Mr. Seaman referred to a 75-ft. span pin connection Post truss, which, in spite of overloading, remained in good condition, owing to the counter rods which are used in this type of truss. Mr. Buck was in favor of retaining the specified wheel loads, as railway managers know what weights of engines and cars they expect to run over the bridges. Mr. Geo. H. Thomson spoke in favor of the plate girder as cheaper than the pony truss, and possessing many advantages. Up to lengths of 110 ft. such girders can be transported and handled in one piece, thus facilitating rapidity of erection. As to wheel loads, he said some managers wanted bridges to carry a certain tonnage rather than a certain engine load, with the idea that a coal train with many flat wheels is harder on the bridge than the engine is. He spoke also in favor of solid floors, and referred to the fact that bridges are generally designed without regard to the superstructure, in spite of the interdependence between substructure and superstructure. A large number of written discussions on this paper have been received.

A paper by Mr. R. B. Stanton on "The Availability of the Cañons of the Colorado River of the West for Railway Purposes" was presented, but not read, and will be read and discussed at a later meeting owing to the interest shown in the subject (Eng. News, Oct. 18, 1890). Major A. F. Sears gave a very interesting description of railway work in cañons in Peru, including the construction of the Chimbote Railway, portions of which have been absolutely obliterated by immense landslides and unprecedented floods. Mr. Nichols also gave some interesting remarks on this same work, and referred to the importance of the work done by Mr. Stanton.

The following candidates were duly elected:

Members.

James W. Deen, Div. Eng., D. & R. G. R. R., Salida, Col.; Wm. M. Gordon, Div. Eng., Yadkin R. R., Albemarle, N. C.; Herbert F. Northrup, Div. Eng., C. & W. M. Ry., Traverse City, Mich.

Associate Members.

Charles A. Cockroft, Syracuse, N. Y.; Howard J. Cole, Asst. Eng., Harlem River Bridge Comm., New York; Wm. H. Converse, Chattanooga, Tenn.; Alexander Potter, Asst. Engr., Stanwix Eng. Co., Rome, N. Y.; F. Rosenberg Eng., Colorado Coal & Iron Co., Pueblo, Colo.; Albert Smith, Borough Eng., Washington, Pa.

The thirty-ninth annual meeting will be held in New York, Jan. 20. The annual reports will be presented, officers for the ensuing year elected, time and place for the next annual convention considered, reports of standing committees presented and discussed, and other business transacted. Arrangements are being perfected for the days and evenings of Jan. 20 and 21.

NEW ENGLAND WATER-WORKS ASSOCIATION.—The regular quarterly meeting will be held at Young's Hotel, Boston, Mass., Jan. 13. There will be a meeting of the Executive Committee at 12:30, and lunch at 1, after which there will be the reading and discussion of a paper on "The East Jersey Water Co.'s Works to Supply Newark, N. J.," by Reuben Shirreff, Sec. Asst. Eng. East Jersey Water Co. The paper will be illustrated with lantern views. R. C. P. Coggeshall, Secretary, New Bedford, Mass.

ENGINEERS' CLUB OF CINCINNATI.—At the fourth annual meeting, held Dec. 18, the committee appointed to draft resolutions on the death of Col. Wm. E. Merrill presented the resolutions, which were unanimously adopted and ordered spread on the minutes and a copy forwarded to the family. Colonel Merrill was one of the founders of the club and its first president. The secretary presented his report, which showed a membership of 105, an increase of 9 during the year. The treasurer's report was also submitted, and the retiring president read a report on the engineering progress of the past year. The following officers were elected: President, Samuel Whinery; Vice-President, Latham Anderson: Directors, W. B. Ruggles, H. J. Stanley and E. A. Hill; Secretary and Treasurer, J. F. Wilson.

OHIO SOCIETY OF SURVEYORS AND CIVIL ENGINEERS.—The thirteenth annual meeting will be held at Columbus, O., Jan. 19, 20 and 21. Jan. 19: reports of officers and of committees on "A Bill for Licensing Surveyors," "Legislation," and "Blanks and Instruments." Also the following papers: "The Muskingum River Bridges," T. C. Connar; "Design for a Brick Arch," A. L. Morgan; "The Jacksonville Bridge," O. Benson. On Jan. 20 there will be presented the reports of committees on "Surveying," and "Code," the president's address, and the following papers: "The County Surveyor," J. C. Grim; "Tracing Old Lines," J. S. Sill; "Practical Experience in Land Partition," S. F. Rock; "Record of Surveys," D. W. Seitz; "City Surveys," W. A. Grim; "Plotting Town Lots," Geo. McGormley; "Notes from the Northwest," A. W. Jones; "Artificial Stone in Construction," S. Bachtell. The report of T. C Mendenhall on "The Boundary Survey Between Ohio and Indiana" will be read. On Jan. 21 there will be the election of officers, presentation of the reports of committees on "Highways," "Drainage," and "Civil Engineering," and the following papers: "Width of City Streets," Samuel Whinery; "Brick Pavements," H. L. Weber; "Specifications for Turnpikes," Geo. H. Hill; "Improvement of County Roads," G. S. Ernis; "Removing Detritus from the Galion Sewers," J. B. Weddell; "Reservoirs of Water-Works, Niles, O.," J. B. Strawn; "Sewers in Small Towns" W. E. Myers; "County Ditch Assessments," H. C. White; and "Details of Ditch Location," A. D. Sheldon.

E. D. Wileman, Secretary, Massillon, O.

AMERICAN FORESTRY ASSOCIATION.—At the annual meeting held at Washington, D. C., Dec. 29 and 30, 1891, a petition was presented to the President in favor of national forest reservations. The report of the Corresponding Secretary showed a gratifying progress on the work of the association. The special effort of the year has been to secure the reservation of portions of the public timber lands of the Western states and territories, under the provisions of the act of Congress of March last. Favorable consideration to the recommendations of the association on the subject has been given by the President of the United States, by the Secretary of the Interior and by the Commissioner of the General Land Office. Several reservations have already been made, and the surveyors from the land office are now examining other tracts which have been recommended as forest reserves.

The report of the Executive Committee was read by Prof. B. E. Fernow. It called attention to the growing needs for the reservation of public woodlands and stated that the committee had devoted all its efforts to securing a liberal application of the law of March 3, 1891.

The report laid down the following as the stand of the association upon this question:

1. Reservations in detached localities, while perhaps preferable to none, will not satisfy the needs of forest protection unless their number is sufficiently large to embrace practically all remaining public woodlands.

2. The all-important problem is that of the management of these reservations, made or to be made, which should be solved at once and simultaneously with the making of the reservations.

3. The principles upon which such management must proceed are laid down in a draft of suggestions for a bill submitted to the committee, in which are provided safeguards to protect prior rights, return of agricultural lands to entry, licenses to prospect for minerals, to camp, hunt fish and otherwise use the reservations legitimately; licenses to cut timber under regulations adapted to the necessities of the locality; protection against fire and theft and such organization as will secure, with the cooperation of state authorities the objects of the reservations and at the same time offer as little friction as possible to existing conditions. The bill calls for a central office in the form of a division in the general land office, with a competent chief and assistants or inspectors, the necessary clerical force and a superintendent for each reservation, with an assistant for every 500,000 acres, to be appointed for his fitness and to serve during good behavior. It also provides for rangers for every 10,000 to 25,000 acres, according to the lay of the land and local conditions, and also for assistant rangers. All appointments to be made upon recommendations by the superintendent. These offices to be under the control and regulations of the Commissioner of the Land Office.

The following officers were elected: President, William Alvord, San Francisco; Treasurer, Henry M. Fisher, M.D., Philadelphia; Recording Secretary, Dr. N. H. Eggleston, Washington, D. C.; Corresponding Secretary, Edward A. Bowers, Washington; Executive Committee, B. E. Fernow, chairman, H. B. Ayres, Gen. J. Grant Wilson, Col. E. T. Ensign, Warren Higby, and Henry E. Pellew. The vice-presidents from the several states were re-elected.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting of Jan. 2, Past President Henry G. Morris in the chair and about 30 persons present, the secretary announced that the annual meeting would be held Saturday, Jan. 16. Mr. Howard Murphy read a biographical sketch of Mr. James F. Smith, C. E., whom he proposed nominating for honorary membership. Mr. F. H. Lewis concluded the discussion of his paper on The Use of Soft Steel in Bridges and the accompanying Specifications for First-class Bridge Superstructure.

The secretary read, for Mr. Emile Low, a paper entitled A Large Land Slide, of which the following is an abstract. The slide referred to occurred in a cut 543 ft. long, and of about 50 ft. maximum depth, on the line of the Clinch Valley division of the Norfolk & Western Railroad, in Southwest Virginia, about 30 miles from Graham Junction on the New River division. The ground fell but slightly, transversely to the axis of the line, but the limestone rock in which the cutting was made, and which occurred in layers about 2 ft. thick, lay at an angle of about 45°, the line of cleavage being about parallel with the railroad line. This stratum was overlaid with one of earth and loose rock. In consequence of the dip of the rock, the lower side of the cut, as shown in a photograph accompanying the paper, was nearly vertical, while the slope of the upper side was much flatter. The amount of material taken from the cut by the contractor before the occurrence of the slide was nearly 28,000 cu. yds. The cut was dressed up in good shape, and the track laid through it about the latter end of May, 1889. At this time there was no visible indications of any tendency to slide, but on the night of Saturday, May 25, 1889, or six days before the memorable Johnstown flood, considerable rain fell, and early the next morning the slide occurred, unobserved by anyone. The material, as will be readily understood, all came in from the upper side of the cut, evidently following the dip of the rock. About 400 lin. ft. of the track were covered to an average depth of over 20 ft. with about 6,000 cu. yds. of rock and earth intermixed.

Day and night forces, each consisting of about 50 men, were organized, and the accumulation of debris was attacked at 5 different points, five at each end of the cut by dumpcars on narrow gage tracks, and by three derricks placed close to the edge of the cut on top, two of them on the lower side and one on the upper side. The two on the lower side were worked by means of a steam hoisting engine and the other one by hand. As much of the material consisted of large slabs of limestone, too large to handle, considerable blasting had to be done. Some little interruption from rain was experienced, but by July 3 the entire mass had been removed and tracklaying was resumed on the following day, July 4. The narrowness of the cut, which was only 14 ft. wide at subgrade, and the slopes of which were only ¼ to 1 for the lower 10 ft., greatly impeded the progress of the work, as only one car could be loaded at the face of the cut at one time. The cost of the removal of the slide was nearly $6,500. The only explanation of this slide which occurs to the writer is that there may have been an enormous "mud-seam" between the layers of the rock and extending from one end of the cut to the other. The cutting away of the toe by the excavation allowed the superincumbent mass to slide upon this wet seam.

In discussion Mr. E. V. d'Invilliers said: It appears to me that the cause of this slide is not far to seek. In the region referred to, with which I am very familiar, land slides are of frequent occurrence, and are due to the geological structure of the region. The formations are badly faulted, strata 2,000 ft. apart geologically being found in close contact. This faulting gives rise to abnormal cleavage, with segregation of clay bands to an extent not found under other circumstances. To the west of the locality referred to, on the Louisville & Nashville Railroad, and on the further side of the Alleghany escarpment, an enormous slide occurred in rocks of a totally different character, but similarly faulted. The ground was practically solid, and its appearance gave no cause for fearing a slide. Nevertheless, a slide occurred which cut off communication for several days, and the removal of which entailed a much greater expense than in the case of Mr. Low's paper.

John C. Trautwine, Jr., Secretary.

COMING TECHNICAL MEETINGS.

ATLANTA SOCIETY OF CIVIL ENGINEERS.
Jan. 12. Secy., Parker N. Black, Capitol Block.
DENVER SOCIETY OF CIVIL ENGINEERS.
Jan. 12. Secy., Geo. H. Angell.
INDIANA ENGINEERING SOCIETY.
Jan. 12-14. Purdue Univ., Lafayette, Ind. Pres., E. I. Morrison.
NORTHWESTERN SOCIETY OF ENGINEERS.
Jan. 12. Occidental Block, Seattle. Secy., E. H. Warner.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Jan. 13. Secy., C. Hoering, Augusta, Kan.
NEW ENGLAND RAILROAD CLUB.
Jan. 13. United States Hotel, Boston. Secy., F. M. Curtis.
"Locomotive Boilers and Their Attachments."
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
Jan. 14. Secy., O. H. Landreth, Nashville, Tenn.
TECHNICAL SOCIETY OF NEW YORK.
Jan. 4. 194 Third Ave. "Boiler Inlets."
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Jan. 15. Union Station, St. Paul.
ENGINEERS' CLUB OF PHILADELPHIA.
Jan. 16. 1122 Girard St. Secy., H. Murphy.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Jan. 16. Helena.
WESTERN RAILWAY CLUB.
Jan. 18. Rookery Building, Chicago. Secy., W. H. Marshall.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Jan. 18. Secy., S. E. Tinkham, City Hall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 19. Secy., F. H. Harlow, Pittsburg, Pa.
ENGINEERS' CLUB OF ST. LOUIS.
Jan. 20. Secy., Arthur Thatcher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 20. Secy., P. Collingwood, 127 East 23d St., New York.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 21. Secy., H. T. Bovey, 112 Mansfield St., Montreal, P. Q.
ENGINEERS' CLUB OF CINCINNATI.
Jan. 21. Secy., J. F. Wilson.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Jan. 21. Secy., T. G. Philfeldt, 118 Adams St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Jan. 21. At Atlanta, Ga. Secy., F. A. Charlot, Macon, Ga.
NEW YORK RAILROAD CLUB.
Jan. 21. Rooms of Am. Soc. M. E., 12 W. 31st St.
"Air Brakes in Freight Service."
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Feb. 1. Secy., C. L. Annan.
ENGINEERS' CLUB OF KANSAS CITY.
Feb. 1. Baird Building. Secy., H. Goldmark.
WESTERN SOCIETY OF ENGINEERS.
Feb. 3. Secy., J. W. Weston, 509 La Salle St., Chicago.
ENGINEERS' CLUB OF MINNEAPOLIS.
Feb. 4. Public Library Bldg. Secy., F. W. Cappelen.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Feb. 5. Secy., E. K. Smoot, 408 Commerce St.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Feb. 5. Secy., H. Baxter, 56 Euclid Ave.
TECHNICAL SOCIETY OF THE PACIFIC COAST.
Feb. 5. Secy., O. von Geldern, 512 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
Feb. 6. Secy., P. Valentine. At 281 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
Feb. 6. Union Station, St. Paul.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL.

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Tuesday afternoon; new advertisements, Wednesday afternoon; transient advertisements, not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

The index for Volume XXVI. of Engineering News, July to December, 1891, will appear with our next issue. Subscribers not receiving it are requested to promptly notify us.

We give this week a second article on mild basic steel, a translation of a recent lecture by the chief engineer of one of the principal German steel works, summarizing the results of an exhaustive series of tests carried out for the German State Railways. Additional evidence is given of the fact that wrought-iron is even more injured by rough treatment and poor workmanship than is low steel; and some interesting experiments are recorded upon the effects of working iron and steel at a blue heat. It is pretty well known now that steel should never be worked at a blue heat; but it is by no means so well known that wrought iron also suffers by being worked at this temperature, losing its resilience in some of the tests reported even more than the hard steel.

In reference to what we had to say recently in regard to motors for aeroplanes, a subscriber calls our attention to the fact that Mr. Maxim has already obtained 120 HP. effective power from an engine and boiler weighing only 950 lbs. as follows:

2 compound engines, 300 lbs. each.....	600 lbs.
Boiler.....	350 "
Total, giving 120 HP. of effective power.....	950 lbs.

This amounts to less than 8 lbs. per HP., to which is to be added about 1 lb. per HP. hour for fuel. Moreover, by raising the boiler pressure to 300 lbs., it is hoped to develop as much as 300 H.P. from this engine, and 200 HP. is counted on with some confidence.

From this it will be seen that the problem of a suitable motor for a flying machine is pretty well solved already. We shall all wait with curiosity to see what Mr. Maxim will do with his motor. If he succeeds in his present efforts he will at least revolutionize the art of war, and perhaps do away with it by converting it into wholesale murder.

The engineman of the elevated train responsible for the collision described last week, which it will be remembered was on a dead straight track in broad daylight, with full knowledge of an existing block, and in the face of a red flag attached to the rear of a train only a block or so beyond the station at which the colliding train had just stopped, gave to the press the following curious and rather mixed description of how it all came about. It is of interest only as a study of human nature, as showing how the best of men, like Jove, will nod at times, for the man stated with just pride that he had been 14 years on the road, "and there has never been before a scratch against my name." He says:

"It happened in this way: I was bringing a train down from 58th St. and there was a Harlem train just in front of me. I did not know about the block at Park Place, but, as I afterward learned, the engineer on the Harlem train did know of it. It is the rule that we are all warned, but I suppose that when the agent warned the engineer ahead of me he thought that sufficient. When I arrived near Franklin St. I saw that the train just ahead of me was to be side tracked, and the engineer of it told me that there was a block on the road. I went on slowly down toward Chamber St. The sun was very bright and it was right in my eyes, and the rear car of the train that was stopped was in the shade of a big building. I could not see it. I shaded my eyes with my hand and looked out of the fireman's window. I then saw it just ahead of me.

"I jumped to the throttle and reversed, but I was too late. I was on the train and we struck the rear car The danger flag was out, but the other rule of the road was not complied with. It is the rule for the brakeman to get off the train and walk down the track, waving his red flag. There was no brakeman in the rear of the car that I struck. It is no use whatever for a red flag to be stuck up on the end of a car and not to be waved so as to attract attention."

A correspondent asks us how it happened that we had nothing to say on Senator Cullom's bill to provide for selecting a standard car coupler, etc. He asks if we approve it. By no means; the bill was and is a singularly unwise one in its main provisions, but for that very reason it is hardly worth discussing, as it is not likely to pass the committee stage and come formally before Congress, and is still less likely to become law. In saying this we do not forget Senator Cullom's prominence in Congress, nor the good work which he has done in the past, but it is so evident to any one familiar with the situation that the bill, if passed, would be likely to do more harm than good that it seems to us quite sure to be riddled in committee and there die a harmless death. The only legislation which, in our opinion, is needed or justifiable is (1) that all couplers hereafter applied to new cars to be used in interstate commerce shall conform to the present M. C. B. standards as to type and lines, as well as to any further standard details which may be adopted by the M. C. B. Association and approved by the Interstate Commerce Commission; and (2) that after the year 1900 (at latest) no freight car shall be used in interstate commerce which is not so equipped. These two provisions, with suitable penalties for their violation, and with analogous provisions in regard to automatic freight train brakes, could do nothing but good, in our judgment. To go further and attempt to standardize any particular make of coupler or brake by act of Congress, with or without a plebiscite of railway employees, could do only harm.

Another year has passed and gone, and the "Brooklyn Bridge question" stands exactly where it did a year ago, and four years ago, as respects any overt attempts to increase its overburdened transit facilities. Two or three buildings have been bought and torn down, and a languid beginning made toward getting ready to do something some of these days, but on the ground that money or condemning powers or what not are lacking, everything is now at a standstill. It is all but impossible to suppose that these delays could have occurred if there were any real willingness or desire to put to the cruel test of experience the alleged "adopted plans." Agitation of the matter, due to the plain necessity of some large expansion of facilities, began with 1886. On Feb. 23, 1888, the first Board of Experts reported. The report was not to the Trustees' liking, and they proceeded at once to adopt what their Board of Experts had condemned, and to condemn what it had recommended. Nevertheless they did nothing to carry out their adopted plans, until on May 12, 1890, they appointed a second Board of Experts, which reported Jan. 10, 1891, that the Trustees were all right and the former Board of Experts all wrong, and that the old "adopted plans," without any modifications of moment, would in fact result in much more than doubling the existing capacity. The arguments which induced this conclusion are not for us to judge. If the press reports were correct, each member of the Board had 4,000 good reasons for reaching it, if he had no others, for each was paid $5,000 for his opinion in favor of the Trustees' adopted plans, whereas the former Board of Experts were paid only $1,000 each for an investigation and report at least as long and as elaborate, by at least as eminent engineers.

Fortunately the appeal to experience, however it may be delayed, cannot be escaped from. Pending that appeal, the last word has been said on the subject. We have predicted, and now again predict, what will be the result of that appeal. No increased capacity of any moment will be obtained; no relief from the existing pressure, even for a day, will result; but there will result a decided increase in the tendency to delay and to accident. When the appeal to this infallible court of last resort begins, we shall have pleasure in laying before our readers, from time to time, in contrasting columns, what was promised and what has been accomplished. Until then, we shall content ourselves with calling attention in some early issue of each succeeding year, to the fact that the appeal has not yet been hazarded.

THE MINERAL STATISTICS OF 1891.

Our esteemed and enterprising contemporary, the "Engineering and Mining Journal," has done itself great honor for some years past by making its first issue of each year a special one devoted chiefly to the mineral statistics of the preceding year, which it has succeeded in compiling by with remarkable promptness, and yet, as it is but just to add, with a very close approach to accuracy. This feature of the paper is now well understood by producers of metals and minerals, and we may reasonably expect to see each of these annual issues an improvement on the last. Certainly this present issue is a decided advance upon the last one, which we reviewed just a year ago, and then thought a very notable production.

The present special issue contains no less than 78 pages of reading matter, all devoted to mineral statistics exclusively, to which is added 94 pages of advertisements. It is stated, and we do not doubt with truth, that if published in octavo book form, similar to the official "Mineral Resources of the United States," the statistical contents of this issue would alone form a book of about 450 pages, but whereas official statistics do not come out until a year or so after the date at which they close, this appears within two days thereafter.

With such rapid work as this, some imperfections of form and substance are all but inevitable. We have discovered and corrected a few of these in what follows, as well as made some of the material more readily comprehensible by bringing scattered records together and adding a few percentages, etc. But on the other hand, we have every reason to believe that the records given are in the main carefully edited and trustworthy, while of course much fuller than the brief abstract of the more salient facts, which we present below, can be made.

It is well enough that the government and official bodies should follow after such quickly compiled records as this and correct at leisure their errors, but for all the practical uses to which statistics are put those given in this special issue are quite as useful as if they were fractionally accurate. Moreover, the records are not merely statistical, but include many technical details and prognostications of the future.

We proceed to summarize a few facts only in regard to our main metallic and mineral products, referring those desiring greater detail as to any product to the issue itself. As a whole the past year has been one of healthy and vigorous growth, despite the financial troubles with which it opened, the effect of which has not yet fully passed away.

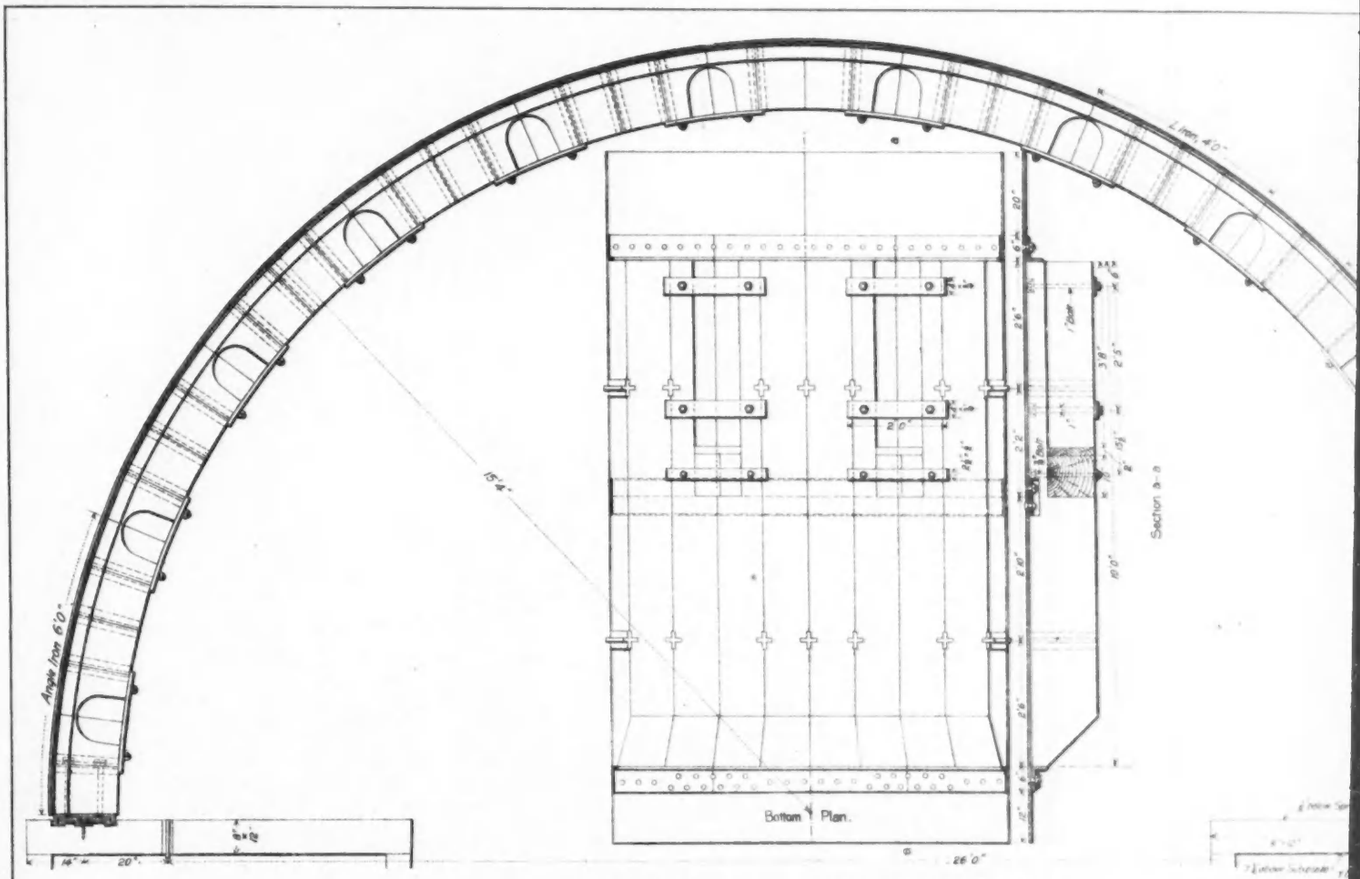
The production of aluminum on a large scale may be said to have begun in 1888, since which the following amazing progress has been made:

	1887.	1888.	1889.	1890.	1891.
Production, lbs..	19,000	47,468	94,881	163,820	
Imports. " .. .1,260	1,348	699	2,051	1,625	
Price, per lb.....	$3.42	$2.50	$2.00	$1.00	

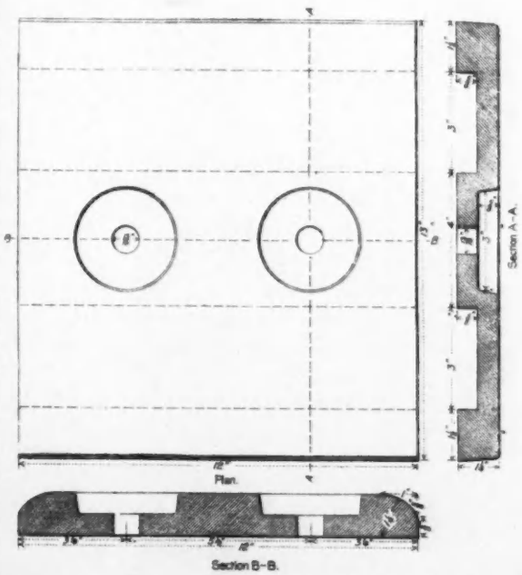
In addition to its rapidly increasing use as a substitute for German silver and brass, aluminum is now used in steel castings by all the important American steel foundries. It has been sold here in the past year as low as 75 cts. per lb., (and even for a time at 50 cts. for competitive purposes), and in Germany at 81 to 68 cts., which price, since November, has been reduced to 50 to 60 cts. per lb.

The imports of crude antimony, which for the five years 1885-89 ran pretty uniformly at 2,600,000 lbs, increased in 1890 to 3,315,659, an increase of about 25%. Our production is very small.

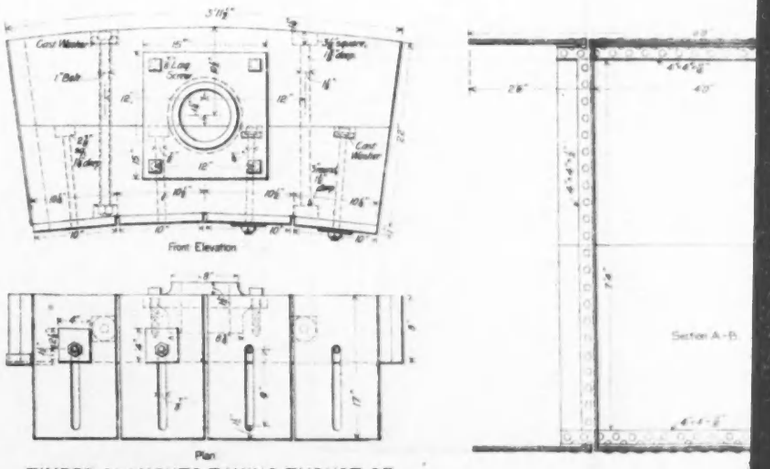
The imports of crude asbestos from Canada were slightly less in 1890 than in 1889, but since 1885 the imports have increased from $73,000 to $250,000



REAR ELEVATION OF SEMICIRCULAR ROOF SHIELD.



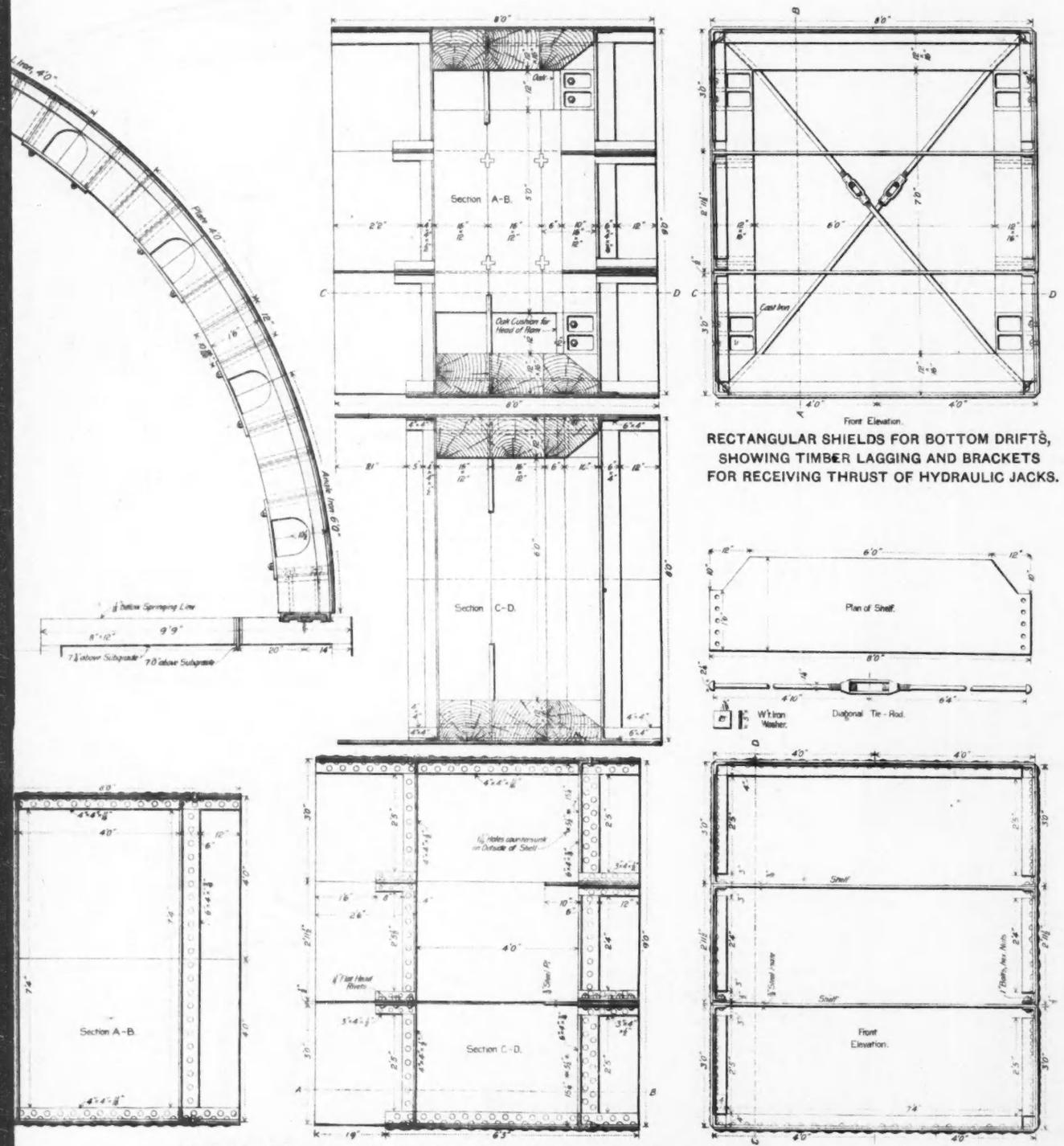
CAST-IRON BEARING PLATE ON CAPS OF BOTTOM DRIFTS.



TIMBER SEGMENTS TAKING THRUST OF HYDRAULIC JACKS AT REAR OF SHIELD AND SUPPORTING BRICK-WORK.

HYDRAULIC SHIELDS IN USE IN DRIVING YOR

RICHARD RANDOLPH, CHIEF ENGINEER



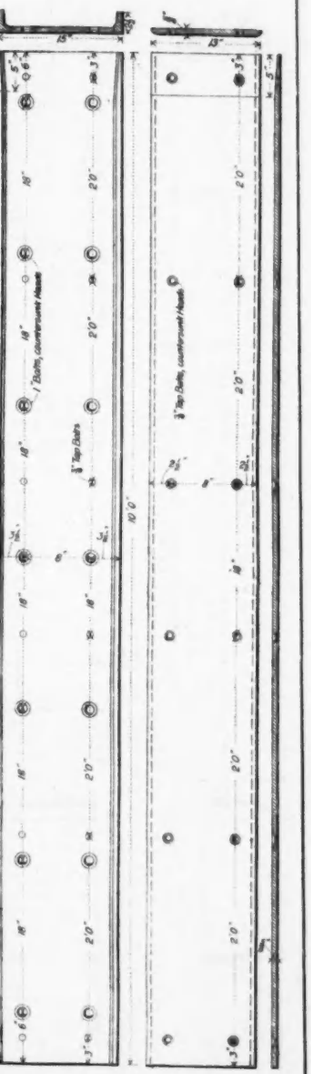
RECTANGULAR SHIELDS FOR BOTTOM DRIFTS, SHOWING TIMBER LAGGING AND BRACKETS FOR RECEIVING THRUST OF HYDRAULIC JACKS.

SECTIONS AND FRONT ELEVATION OF IRON SHELL OF RECTANGULAR SHIELDS.

CHANNEL A
BOTTOM OF

RIVING YORK ROAD TUNNEL OF THE BALTIMORE BELT RAILROAD.

RYAN & McDONALD, CONTRACTORS.



ANNEL AND FRICTION PLATE ON
TTOM OF SEMICIRCULAR SHIELD.

CHAS. HART & SONS, LITH., 90 VESEY ST., N. Y.

worth per year, the present price being $170 per ton.

The asphaltum industry is somewhat of an exception, in that it shows a decreasing proportion of home production to imports. Since 1876 the figures compare as follows:

	1887.	1888.	1889.	1890.
Production, tons	4,000	53,800	51,735	40,811
Imports, tons	30,898	36,494	61,952	73,345

The home product comes chiefly from Utah and Colorado.

Bromine, the product of which for the eight years 1883-90 ran pretty uniformly at 300,000 lbs., jumped last year to 415,000 lbs. There has been one such jump before, in 1886, which was not repeated.

Anthracite coal production made a great jump last year to 40,414,907 tons, the next highest year being 1888, 38,145,718 tons. Its progress since 1860 has been at the following rapid rate, in millions of long tons:

1860.	1870.	1880.	1885.	1890.	1891.
8.51	16.18	25.41	31.62	35.86	40.41

The bituminous coal output is only shown up to 1889, but the editor gives an estimate for 1891, the record comparing as follows, in millions of tons:

1887.	1888.	1889.	1890.	1891.
81.40	93.07	96.63	....	98.00

With this may be compared corresponding figures for the output of the chief European countries, in millions of metric tons:

	1880.	1887.	1888.	1889.	1890.	Incr. 1880-90
Great Britain.....	149.2	161.7	172.7	179.7	184.5	35.3 (23.7%)
Germany........	47.0	60.3	65.4	67.3	70.0	23.1 (49.0%)
Austria........	5.9	7.8	8.3	8.6	8.9	3.0 (51.[illegible]%)
France........	18.8	2[illegible].8	22.2	23.9	23.3	7.5 (4[illegible].0%)
Belgium........	16.9	18.4	19.2	19.9	20.4	3.5 (20.6%)

We are still considerably below Great Britain in coal output, but a few more years will see the gap closed, apparently.

The copper product of the United States showed a very large increase in 1891. It rose to 292,620,000 lbs., of which a quantity equal to 72% was consumed at home, and 38% exported, a total of 110%, indicating that the stock on hand was drawn upon to the extent of 10% of the year's output. The world's product of copper in 1891 was about 300,000 gross tons, of which the United States produced 43%.

The consumption of copper in the United States has increased in the following tremendous ratio:

	1850.	1860.	1870.	1880.	1889.	1891.
Consumption, tons.	6,710	7,116	12,342	26,799	95,000	105,000
Do. per capita, lbs.	0.55	0.41	0.60	1.01	3.01	3.02

If this ratio of increase keeps on, what will be the consumption of copper in the United States by 1950? May all our readers live to see the figures and still survive!

The production of copper shows the following astounding increase, not in a period of 41 years, be it noted, like the above record of consumption, but in the brief period of nine years:

Increase of Copper Production in the United States, by Districts, Within a Period of Nine Years.

[In millions of pounds.]

District.	1882.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
Lake Superior..................	57.16	59.70	69.35	72.15	79.92	76.03	86.[illegible]9	87.[illegible]0	99.75	109.57
Arizona	17.98	23.87	26.73	22.71	15.66	17.72	33.20	32.93	34.90	39.70
Montana..................	9.06	21.66	43.09	67.80	57.61	78.70	98.50	104.54	111.20	113.20
All others..................	7.62	8.92	8.64	8.30	8.07	12.78	13.19	18.71	19.07	30.35
Total product..........	91.82	117.15	147.81	170.96	161.26	185.23	231.48*	243.68	264.92	292.62

* An error in the original of about 13 million pounds is corrected in this total.

The amazingly rapid increase of the Montana product, which has made it the chief center of production is the main feature of this table. The Lake Superior output has increased tolerably fast, but Montana has passed it as if it were standing still. The "other" districts are in their order of importance, "foreign ores" (11.5 million pounds), Colorado 7.00), California (3.75) and Utah (1.7) with a trifling Eastern and Northern product.

Between 1883 and 1890, while the copper product of the United States increased 126 per cent., that of the rest of the world increased only 20.5 per cent. The mean yearly price per pound in London and New York has during the same period compared as follows:

Cts. per lb.	1883.	1884.	1885.	1886.	1887.	1888.	1889.	1890.
London	13.8	11.9	9.6	8.8	9.2	17.2	10.8	11.7
New York	15.9	13.9	11.1	11.0	11.2	16.7	13.7	15.7
Difference	2.1	2.0	1.5	2.2	2.0	—0.5	2.9	4.0

The duty during this period has been (or at least was in 1890) 4 cts. per pound, which was reduced by the McKinley bill to 1¼ cts. Why any duty whatever was left on copper in view of the existing economic situation it is hard to see, however favorably one may look upon protection as a general policy, inasmuch as no copper worth mentioning has been imported for 20 years, and vast quantities are yearly exported, now aggregating 55,000 short tons. As there is every reason to believe that in the future as in the past the American price will rule higher than the European by about the amount of the duty (there being no change in the conditions which have existed for many years), the American people will be paying to the copper producers, for two-thirds of their product, 1¼ cts. per pound more than they sell the other third for to foreign users of the metal. As it stands to reason that they would not produce the other third unless they made a profit on it, it looks very much as if the extra 1¼ cts. was simply "velvet" to the producers, not needed to encourage production.

The new tin duties stand on an entirely different basis, and are much more in accordance with the theory of protection. The results as respects the production of metallic tin have so far not been great. Our contemporary summarizes them as follows:

The only mines which have so far actually produced tin are the Temescal, in Lower California, but the quantity has been small. It is confidently hoped that 1892 will be a much larger production, though it cannot be of such proportions as would influence the markets of this country, much less those of the world. In the meantime the duty of 4 cts. per lb. on tin will become operative on July 1, 1893, unless Congress should enact a different law.

The market price is about 20 cts. No details are given as to the production of tin plate in the United States.

The production of gold has remained nearly constant at 33 millions since 1880. In the past eight years the coinage values of gold and silver produced have been as follows in millions of dollars:

	1884.	1885.	1886.	1887.	1888.	1889.	1890.	1891.
Gold........	30.8	31.8	34.9	33.1	33.2	33.0	32.8	33.0
Silver........	48.8	51.6	51.3	53.9	59.2	64.8	70.5	76.3
Price of do. cts. per oz....	111.3	103.5	99.5	97.8	94.0	93.6	104.9	101.2

Coinage value of silver, 129.29 cts. per oz.

In regard to silver our contemporary makes the pithy remark:

Silver production has steadily increased, even the decline in the Comstock having been insufficient to arrest the growing figures. In recent years the rate of increase has been more rapid, and this promises to continue. The present ratio of production is 1 gold to nearly 36 silver by weight. It is easy to see how difficult it is to maintain a value ratio of 1 to 16 in the face of a production ratio of 1 to 36.

The world's production was 116 millions gold to 166.7 millions (coining value) silver. In 1873 the world produced only 81.8 millions of silver, against 96.2 millions gold.

In pig iron production we have to mourn a decrease from 10,307,028 short tons in 1890 to 9,000,000 tons in 1891, a loss of about 13 per cent., the whole of which was incurred in the first half of 1891. On the other hand the British output showed an improvement over last year's output (when it was 8,960,000,000 short tons) of some 3 per cent. in the first six months. It is probable, therefore, that our output this year will again fall slightly below the British. The prospects are good, however, for a very heavy output in 1892.

The steel rail output suffered an extraordinary decrease last year to nearly one-half of what it was in 1890. In thousands of short tons the output for the past 14 years (to which we subjoin the mean price of the year) has been as follows:

1878.	1879.	1880.	1881.	1882.	1883.	1884.
550	686	954	1,330	1,4[illegible]8	1,[illegible]87	1,112
$42.25	$48.25	$67.50	$61.12	$48.50	$37.75	$30.75

1885.	1886.	1887.	1888.	1889.	1890.	1891.
1,079	1,769	2,373	1,558	1,695	2,09[illegible]	1,090
$28.50	$34.50	$37.12	$29.87	$29.25	$31.75	$30.00

The decrease in output, at 1.13 tons of pig per ton of rails, accounts for a decrease of 1,136,000 short tons in pig iron output,* the total decrease being 1,331,000 tons, so that, except for rails, almost as much pig iron was produced and consumed in the United States in 1891 as in 1890. The price of steel rails was maintained with remarkable uniformity at $30 in New York, there being no variations therefrom except for a few sales at $28 in January, 1891. The world's production of pig iron has been as follows in thousands of metric tons of 2,204 lbs.:

	1860.	1870.	1880.	1888.	1889.	1890.
World............	7,360	12,095	18,385	23,[illegible]95	25,3[illegible]4	27,146
U. S............	8[illegible]7	1,695	3,9[illegible]5	6,[illegible]96	7,728	9,348
British...........	3,896	6,072	7,89[illegible]	8,028	8,380	8,001

The lead output has recovered from the check of last year, and in 1891 was the largest ever known. The output in thousands of short tons has been:

1885.	1886.	1887.	1888.	1889.	1890.	1891.
129.4	135.6	160.7	186.3	190.3	181.5	205.5

The price last year averaged 4.35 cts. per lb., against 4.48 cts. in 1890. Some 20 thousand tons were imported in 1890, a phenomenally large quantity, in spite of the duty of 2 cts. per lb. Very little has been imported this year. Continued large increase of output is expected.

Our nickel output is practically all from one mine, which is rapidly approaching exhaustion. About 145,000 lbs. was produced last year, largely from Canadian ores, against some 200,000 lbs. per year for the five preceding years. Our imports are now about three times our production. The price of nickel was $2.60 per lb. in 1876, but fell to 90 cts. in 1883 and 60 cts. in 1886, where it now stands, having risen and fallen a few cents between times.

The petroleum output has considerably increased over the large output of 45,000,000 bbls. in 1890, but exact figures for the increase are not yet available.

The South Carolina phosphate output remains about the same as for three years past, at 500,000 tons. The Florida output was only 159,731 tons, but is likely to rapidly increase. Small as was this quantity it broke down the price from $7 (for 60% phosphate) to $6, and from $12 (for 75 to 80% phosphate) to $9. It is alleged that the extent of the Florida deposit has been exaggerated.

Our zinc output has largely increased. In tons of 2,240 lbs. the world's product and our own has been as follows:

	1886.	1887.	1888.	1889.	1890.	1891.
World.....	292,662	290,810	316,927	329,890	343,265	....
U. S........	38,072	44,947	49,922	52,812	60,120	68,303

The product of no other large producer except the United States is increasing rapidly. Austria has a small and growing product of 7,135 tons.

As a whole these statistics fully bear out the conclusion that our progress in metallurgical and mining industries in 1891 was very satisfactory, and that there is a good chance of its being still more so in 1892.

FRANCHISES OF WATER WORKS COMPANIES.

Over half of the water-works of the United States, about 57 per cent., are owned by companies. These companies are, in reality, public servants clothed with more or less authority and performing public functions with the privileges of condemning private property, using public streets and making profit from consumers. As the public surrenders these privileges to companies and has a right to expect and demand good service in return, it may well be asked in what way and to what extent do our cities and towns when granting franchises provide for good service, fair charges, resumption of the franchises and the ultimate ownership by the municipality when desired.

The question has almost as many answers as there are water companies, for while in some states nearly all the powers granted are conferred upon the company directly by the state when it is chartered in others each municipality fixes most of the privileges which the company may enjoy and the duties which it must perform when the franchise is granted, and all have more or less opportunity to secure proper agreements from the company, either in granting the franchise or in making the contract for hydrant rental. All franchises should contain provisions for regulation of rates and for the purchase of the works by the town at a fair price. The price

* On the editorial page of the "Engineering and Mining Journal" this quantity is wrongly computed as 1,300,000, owing to a confusion of short tons (2,000 lbs.) with long tons (2,240 lbs.).

Table 12—S.

Length of Franchise in Years of 391 Water Companies.

	Years. 5	10	15	20	21	25	30	40	50	99	Perpetual.	Total reporting.	Total number of companies.
N. E.	..	..	1	3	.	2	2	1	1	..	13	23	156½
Mid.	1	9	..	4	..	3	3	..	2	6	13	41	333½
S. Atl.	..	..	..	3	..	7	6	1	2	3	..	22	64
S. Cent.	..	..	..	9	..	5	8	..	..	..	5	27	60
N. Cent.	1	4	5	35	1	12	21	..	4	..	2	85	146
N. W.	..	..	1	36	9	13	12	..	1	2	4	78	123½
S. W.	..	1	..	36	..	10	5	..	12	..	..	64	115
Pac.	..	1	2	6	..	14	2	..	24	..	2	51	160½
Total U. S.	2	15	9	132	10	66	59	2	46	11	39	391	1,159

Table 13—S.

Provisions of Water-Works Franchises for the Regulation of Rates and Purchase of Works by the City.

	Rates. No. of companies. Total.	Reporting.	Regulation. None.	Subj'ct to approv'l of ci'y.	Max'm rates fixed.	Rates fixed.	Purchase. Time. No. report'g.	No provisi'n.	Any time.	Fixed int'ls.	Not given.	Price. No. repor'g.	Cost.	Nam'd.	Fixed by arb'tion.
Me.	35	20	20	.	..	..	18	14	2	2	..	3	1	..	2
N. H.	25	6	6	..	..	..	6	6	..	..	..	..	..	..	..
Vt.	8	3	3	..	..	..	3	2	..	1	..	..	..	..	..
Mass.	45½	21	19	..	..	2	20	5	8	3	4	9	.	2	7
R. I.	9	6	6	..	..	..	6	3	..	3	..	1	..	..	1
Conn.	34	14	14	..	..	..	14	12	2	..	..	2	..	..	2
N. E.	156½	70	68	..	..	2	67	42	12	9	4	15	1	2	12
N. Y.	118	42	32	1	6	3	42	26	4	9	3	5	1	..	4
N. J.	36	13	12	..	1	..	12	11	..	..	1	2	1	.	1
Pa.	164½	56	50	2	2	2	56	50	2	4	..	5	1	1	3
Del.	1	..	..	..	..	..	.	..	..	..	..	..	..	..	..
Md.	14	8	7	1	.	..	8	6	1	1	..	..	..	..	..
Mid.	333½	1.9	101	4	9	5	118	93	7	14	4	12	3	1	8
Va.	21	3	2	..	1	..	3	2	..	1	...	..	..	..	..
W. Va.	5	3	1	..	1	1	3	1	..	2	..	1	..	..	1
N. C.	12	4	2	..	..	2	4	1	..	3	..	..	..	..	..
S. C.	6	3	1	..	1	1	3	..	..	3	..	..	..	..	..
Ga.	10	3	1	..	2	..	3	1	..	2	..	1	..	..	1
Fla.	10	7	3	..	4	..	7	2	1	4	..	4	..	..	4
S. Atl.	64	23	10	..	9	4	23	7	1	15	..	6	..	..	6
Ala.	19	3	..	..	1	2	3	..	..	3	..	1	..	..	1
Miss.	6	4	1	..	3	..	3	1	..	2	..	..	..	..	..
La.	3	2	..	..	2	..	2	..	..	2	..	2	1	..	1
Tenn.	14	9	2	.	4	3	6	1	1	4	..	1	..	..	1
Ky.	18	5	4	..	1	..	5	4	..	1	..	1	..	..	1
S. Cent.	60	23	7	..	11	5	19	6	1	12	..	5	1	..	4
O.	28	10	3	..	4	3	8	1	..	6	1	4	..	.	4
Ind.	23	11	2	..	7	2	11	1	1	9	..	7	..	1	6
Mich.	28	13	7	1	3	2	..	..	..	..	..	..	..	..	.
Ill.	33	10	3	1	3	3	12	3	7	..	2	2	..	..	2
Wis.	34	13	6	..	3	4	13	2	..	11	.	5	..	..	5
N. Cent.	146	57	21	2	20	14	44	7	8	26	3	18	..	1	17
Ia.	26	13	3	..	4	6	12	4	1	6	1	4	1	..	3
Minn.	13	..	..	..	.	..	1	..	..	1	..	..	..	..	..
Kans.	46½	11	2	..	2	7	24	1	17	6	..	4	..	..	4
Neb.	14	1	..	..	1	..	2	..	..	2	..	2	..	..	9
S. Dak.	5	1	..	..	1	..	2	..	..	2	..	2	..	..	2
N. Dak.	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Wyo.	6	..	..	..	.	..	2	..	..	2	..	1	.	..	1
Mont.	11	4	2	1	1	..	4	2	..	1	1	1	..	..	1
N. W.	123½	30	7	1	9	13	47	7	18	20	2	14	1	..	13
Mo.	32	17	1	4	4	8	18	..	1	17	..	4	..	..	4
Ark.	11	2	..	2	..	..	2	..	..	2	..	1	..	..	1
Tex.	40	10	4	..	1	5	10	4	1	4	1	3	..	..	3
Colo.	24	5	4	..	.	1	5	3	..	1	1	1	.	1	..
N. M.	8	4	3	..	1	..	3	3	..	..	..	..	..	.	..
S. W.	115	38	12	6	6	14	38	10	2	24	2	9	..	1	8
Wash.	28	8	3	..	2	3	7	5	..	..	2	..	..	..	..
Ore.	15	6	5	..	..	1	4	4	..	..	..	1	..	..	1
Cal.	92½	*	*	*	*	*	36	33	1	2	..	..	..	..	..
Ariz.	3	3	1	..	1	1	3	1	..	1	1	1	..	..	1
Nev.	9	3	3	..	..	..	3	3	..	..	..	..	..	.	..
Utah	4	1	1	..	..	..	2	1	1	..	..	..	..	..	..
Idaho	9	5	4	..	1	..	5	5	.	..	..	..	.	..	..
	160½	26	17	..	4	5	60	52	2	3	3	2	..	..	2
U. S.	1,159	386	243	13	68	62	416	224	51	123	18	81	6	5	70

* Constitution of California provides that rates shall be fixed annually by County Board of Supervisors.

should never include the value of the franchise itself, this always remaining the property of the city, leased or granted to the company for a time, but reverting to it at no distant date, especially when for any cause purchase by the city will not be easy, in order that a new franchise may be granted, if desired, on conditions suitable to the time and changed circumstances.

Provisions from the franchises of over one-third of the water companies in the United States are abstracted below from the information collected for the "Manual of American Water-Works" for 1891. The facts presented are of unusual interest owing to their bearing upon important and practical subjects and to the large number of companies concerned, no extended information of this character ever before having been collected and published. The points covered are length of franchises, regulation of rates and purchase of works.

Table 12-S shows, by groups of states, the length of the franchises of 391 out of 1,159 companies. Two companies have 5-year, 15 have 10-year and 9 have 15-year franchises. The largest number in any one class is 132 in the 20-year. The 20, 21, 25 and 30-year classes together have 267 out of the 391 companies reporting. Of 50-year franchises there are 46; of 99-year, 11, and of perpetual, 39, or 10 per cent. of the number reported. Many of the long-term franchises are, doubtless, really state charters, in addition to which there is some form of contract between the city and company, but each company was included as reported. Over half of the New England companies included and about one-third of those in the Middle States report perpetual franchises, while of all the 50-year franchises reported over half are in the Pacific States. In all but the New England, Middle and Pacific States 20 to 30-year franchises are in the majority.

Where the right to purchase at reasonable intervals is reserved and the franchise regulates, or unquestionably provides that the city may regulate, the rates a long-term franchise is not so very objectionable. Otherwise the franchise should be short, although not so short as to hurt the sale of the company's securities.

Table 13-S shows by states and groups of states details regarding the regulation of rates and provisions for the purchase of works. As to regulation of rates, reports have been received regarding 386 franchises, and of these 243, or about 63 per cent., contain no regulation. Of the remaining 143 it is stated that in 13 cases the rates are subject to the approval or regulation of the city, 68 have maximum rates fixed, and in 62 cases it is merely stated that the rates are fixed. The 93 companies in California, none of which are included in Table 13-S, have their rates fixed yearly by County Boards of Supervisors, in accordance with the state constitution.

In one or more states aside from California, it is believed, local authorities have power to establish rates. New England shows but two companies, both in Massachusetts, whose franchises fix their rates in any way, against 68 with no regulations; but it may be that the general laws in these states make easy the securing of fair rates through the courts or otherwise.

Passing to provisions for purchase we find that of 416 franchises reported on 224 contain no provisions for purchase, 51 provide for purchase at any time, 123 name intervals and for 18 others the time is not described. The New England and Pacific States have the largest number of franchises without provision for purchase, there being 42 out of 67 in New England and 52 out of 60 in the Pacific States. In Kansas over a third of all the companies, 17 out of 46, have franchises providing for purchase at any time, and only one company reports no provision. Of the 192 companies reporting some provision for purchase but 81 state how the price is to be determined. Of these 81 six works may be bought at cost, five for a price named in the franchise and 70, or nearly all, by arbitration, which is probably the most desirable method when proper provision is made for the selection of the arbitrators.

On the whole, the above figures show, so far as mere abstract figures can, that the majority of our cities and towns have been so anxious to secure water, or what is worse, so careless and ignorant, that they have not properly protected their interests in granting franchises, having failed to retain for themselves a reasonable control over water rates, and the privilege of purchasing the works at a fair price whenever, within proper limits, they desire to do so. In addition, some franchises have been given away for all time and others for more than a generation. In the last particular, however, the showing is not so bad, for, as will be seen by referring again to Table 12-S, only 93 out of 391 franchises are for more than 30 years, and 158 are for 20 years or less, there being 132 franchises running just 20 years each. Twenty years seems quite long enough for an ordinary franchise, and in many cases 15 might be better, and, generally speaking, the privilege of purchasing should not come less often than once in five years, or every five years after the first 10 years have elapsed.

Taking into consideration the looseness and faultiness of many franchises both the companies and towns in which the latter operate are to be congratulated on having no more difficulties than they do, although injustice often enough results to both sides, more often, however, to the public, since a water-works company has a practically complete natural monopoly. The lesson to be derived from the foregoing is that in granting franchises to water companies more care should be taken to preserve and secure to the public their natural rights in accordance with past experience and present enlightenment.

Government ownership does not seem to be regarded favorably in Switzerland, according to the "Schweizerische Bauzeitung." According to contract between the directors of the Swiss Central Railway and the Bundesrath, this road was to be sold to the government, and it was thought that other Swiss roads would soon follow suit. The bargain had to be passed upon by a public vote, however, when it was found that nearly two-thirds of the population were opposed to the scheme. The directors of the Swiss Post and Railway Department, Dr. Welti, one of the stanchest advocates of government ownership of railroads, sent in his resignation when learning this result.

The Alumni Association of Stevens Institute at its meeting in February will act on a proposition to secure 250 alumni who will guarantee a yearly payment of $10 each, making a sum of $2,500. This will pay interest at 5% on bonds to the amount of $50,000, which it is proposed to issue to raise funds for building a new laboratory on the northwestern corner of the campus. The building will be 70 × 80 ft. and three stories high. When this building is completed it is intended to increase the limit in the size of the Freshman class to 125. Work on the new building is expected to begin in the spring, and accommodations will be arranged so that a Freshman class of 85 can be admitted next fall. Five new members have been added to the Board of Trustees of the Institute as follows: Andrew Carnegie, Chas. MacDonald, Col. Edwin Stevens, Chancellor McGill and Alexander C. Humphreys.

LETTERS TO THE EDITOR.

THE CATTLE GUARD QUESTION.

Sir: As an engineer who has had some years' experience on the Maintenance of Way Department of one of our large Western roads, I have been very much interested in the accounts published in your excellent papers of Oct. 24, Nov. 14 and 21, and lastly in the official account as given in your issue of Dec. 5, of the so-called Indianapolis cattle guard tests.

The marvelously rapid growth of our railway system and the necessity for building as cheaply as possible compelled the early engineers to adopt the crude wooden or stone pits called cattle guards. The great number of these structures and their simplicity of construction seem to have impressed later engineers with the belief that they should go into track as a matter of course.

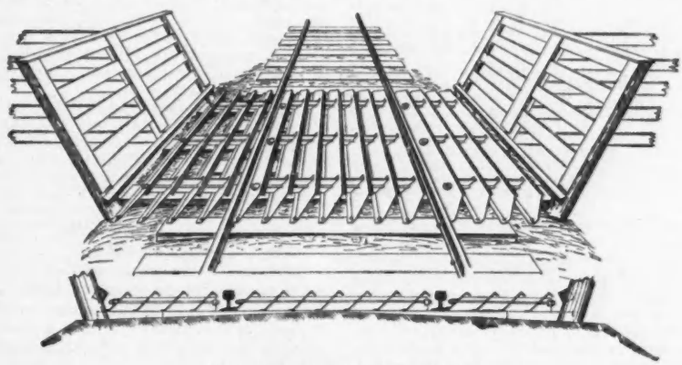
Becoming impressed some years ago with the necessities for the improvement of such structures, the following seemed to me the objections to the old wooden pit and the requirements for a perfect guard. The objections to pit guards are:

(1) A derailed wheel will drop into them and strip the following trucks from the train.

(2) They will catch and hold cattle, which, having the bulk of their bodies below the pilot, will cause derailment.

(3) They are holes into which pedestrians fall at night, causing sometimes fatal injuries.

(4) They are deep but short foundations of the track



THE STANDARD CATTLE GUARD.

which cause uneven roadbed, as frost enters and leaves the ground.

(5) They fill with water, which by freezing gives clear passage for cattle.

The requirements for a good cattle guard are, that it shall avoid all the above and fill the following demands:

(6) It must immediately deter cows and other large cattle in their first effort from seeking to cross.

(7) It must as effectually deter hogs, sheep and other small stock.

(8) It must present no wires, loops, or other openings in which trailing chains or rods can catch.

(9) It must present no sharp edges or teeth to cut pedestrians in case of tripping and falling in the dark.

(10) It must be simple, durable, cheap, easily put down, and have all its parts interchangeable, that it may be removed or repaired easily.

(11) It must project little if any above the rail and must have a simple and secure fastening.

Experienced roadmasters and maintenance of way engineers will weigh these general pros and cons and other local ones in their mind; and if they are anxious to improve their track, regardless of the "good old way," I am confident they will adopt the style of metallic surface guard which most nearly fits their conclusions.

To some the points 3, 4 and 9 may not appear very important, especially to Southerners; but I have known of roads having to pay heavy damages for accidents like case 3; and as to objection No. 4, I have seen "shims" 4 ins. thick put under pit guard stringers to "surface" track because the ground had heaved beside the pit to that extent in a few hours. I believe all Northern roads keep on hand extra long spikes for use under such conditions.

One-half of the necessary effectiveness of cattle guards seems to have been overlooked at Indianapolis, viz., their qualities for stopping small stock, such as sheep and hogs. In fact, the weak point in surface guards up to the present time has been their inability to check such stock.

After considering the above mentioned requirements I have designed, patented, and am manufacturing a guard called "The Standard Cattle Guard," which I believe more thoroughly than any other now in use fulfills the above conditions, having already been in use 16 months. You will see from the above cut that its action is not to form a vibrating footing for the hard hoof of the animal, as in other guards, but by presenting a surface inclined upward the foot slips on said surface till it comes in contact with the upper edge of the next adjoining plate, which presses against the tender ankle above the hoof, thus turning both small and large stock alike.

In conclusion I would say that such tests as given at Indianapolis should be witnessed by representatives of such reputable railway journals as your own, in order that engineers may know practically what are the weak and the strong points in the devices under consideration.

Yours very truly, Benj. Wolbaupter.

Oak Park, Ill., Dec. 21, 1891.

PLATE GIRDER PROPORTIONING.

Sir: In view of your recent publication of Mr. Waddell's paper on "Bridge Design," I beg to offer a few remarks on "Plate Girder Proportioning." Mr. Waddell justly remarks that to-day plate girder proportioning is nothing less than rule of thumb practice, a sorry fact to confess indeed. But when he states that "the exact thickness of the web, and the manner in which it sustains stress can not be determined from theoretical considerations," it would seem that he is a trifle premature. Owing to the exceeding thinness of the web in comparison with the flanges, the action of the girder in sustaining stress is not that of a beam but of a truss; in which case all the shear must be sustained by the web and stiffeners. Let it be supposed that a girder exists without stiffeners under a stress exactly as great as it can sustain with the proper factor of safety. Then at any vertical section of the web there exist two equal and opposite vertical forces which tend to shear the section off. These forces distributed over the area of the web, cause a certain unit shearing stress, acting on every unit of area of metal in the vertical section. Now from analogy with the action of a truss, the web on either side of the section consists of a series of elementary unit tension members running at an angle of 45° with the vertical, and each vertical unit stress is resolved into two forces at right angles with each other and inclined 45° to the horizontal. Hence the shearing stress becomes distributed into a series of unit tensile stresses equivalent to $\sqrt{2}$ times the unit shearing stress. These elementary tensile stresses are transferred to the chords, where they are again resolved into horizontal and vertical components, the former producing compression in the top and tension in the bottom chord equal to the original unit shearing stress, and the latter producing compression on a unit vertical column of the web equal to the original unit shearing stress. Hence for the web to be thick enough to withstand the given loading without buckling the greatest unit shearing stress should not be greater than is given by the formula

$$s = \frac{9{,}000}{1 + \frac{d^2}{3{,}000\ t^2}}$$

where d is the depth in inches and t the thickness.

In this case the web is desired to withstand both tensile and compressive stresses, and hence is seen the poor economy in very deep girders of making the web thick enough to withstand the loading without stiffeners, inasmuch as in the latter case the unit compressive stress becomes so very small in comparison with the allowable unit tension stress.

A perfect design would be one in which the allowed unit stress on every piece of metal in the structure would be the same, as such an arrangement would give the maximum amount of resistance with a minimum amount of material. Hence to approach such a condition in a deep girder, the web ought to be made just thick enough to carry the tension, and the compressive unit stresses above found are sustained by stiffeners placed at a distance apart equal to the depth of the girder.

To determine the size of any stiffener at any point, first find the total shearing stress at this point, and then the unit shearing stress. Then by the formula

$$8 = \frac{9{,}000}{d^2} \text{ find } S.$$
$$1 \times \frac{}{3 \text{ on } t^2}$$

The ratio of S to the unit shearing stress actually existing gives the proportion of the total shear that can be sustained by the web. The remainder will be sustained by the stiffener, which will then be proportioned for that amount of stress by the usual formula for columns.

Hence Mr. Waddell's statement "that almost any web when properly stiffened will be thick enough," is correct down to the limit that the unit shearing stress thereon shall not exceed about 6,500 or 7,000 lbs., which would cause a unit tensile stress in the web of from 9,000 to 10,000 lbs. This investigation shows that the proportioning of a plate girder can be done as scientifically and as definitely as any form of riveted truss. Yours truly,

New York, Dec. 29, 1891. S. W. Fresconi.

FIELD-BOOKS AND TRANSITION CURVES.

Sir: Will you kindly inform me when Mr. Wellington expects to publish his book on Field Engineering? Also, will the work be issued in the columns of Engineering News prior to its publication in book form? I was very much interested in the advance chapters published in Engineering News a year or two ago, particularly those relating to transition curves, as I have had considerable experience with them. I have tried several methods and have come to the conclusion that his is the only practical one. In all the other methods I have examined one is very much hampered by the tables which one has to use, which limit you to certain offsets for certain curves, while under Mr. Wellington's method you can practically use any offset for any curve.

The problem to which they all devote so much space, that of varying the same curve from an intermediate point, has never occurred in my practice. On original location there is no need of setting any points whatever on the transition curve, except at the regular stations, and these can be set over from the regular curve. If your line of sight is obstructed you can move forward, as you would on an ordinary curve.

I would call your attention to the ease with which you can calculate the intermediate offsets for a transition curve with the aid of a slide rule. Suppose you want the offsets for six points in the half length of the curve, set the cube of six (216) on the slide over ½0 (half the central offset) on the rule, then with the slide in this position you find the offset for all the other points, under the cube of 1 (1), that for the first point; under the cube of 2 (8), that for the second point; under the cube of 3 (27), that for the third point, etc. This can be done so quickly that I can figure the offsets and deflections while the transit man is setting up his instrument, and thus avoid the use of any table at all. If you are running your curve with angles the intermediate deflections can be worked in the same way after the deflection is calculated, by using the square of the above numbers, as the deflections increase as the square of the distance.

In his "Economic Theory of Railway Location" Mr. Wellington recommends the use of the slide rule, and I trust he will do the same in his new field book, as it is an instrument that too few engineers are familiar with. I always carry a slide rule with me when on field work and find it invaluable. It can be used to great advantage with the formula $O = \frac{3}{4} n^2 d$, which Mr. Wellington describes as "almost a field book in itself," by substituting .875 for ⅞, as can be done with nearly all minor field calculations.

I have lately been engaged in putting in transition curves on an old road, and have often been very much restricted by the proximity of bridges, buildings, rock cuts, etc., yet it was surprising what an improvement a transition curve 150 or 200 ft. long would make on an 8° or 9° curve.

While one of the other methods may do well enough on a new road where you have few limitations, I consider them impracticable in the revision of the curves of an existing road.

My results are practically the same as Mr. Wellington although I use a different formula for computing the relation of the length of the transition curve to the offset.

This formulæ is $O = \frac{l^2}{24\ R}$; where O = the offset from curve to tangent, l = the length of the transition curve and R = the radius of the main curve.

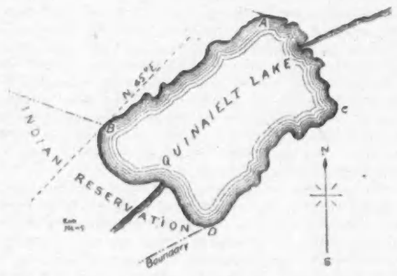
Yours respectfully, Geo. P. Snyder,
Asst. Engr. P. & R. R. R.

Tamaqua, Pa., Dec. 19, 1891.

[In answer to the above, and to numerous other correspondents who have made inquiries from time to time, we will state that Mr. Wellington's methods for putting in transition curves will be described in full in this journal within a few weeks. Circumstances which could not well be controlled (one of which was a prolonged absence in Europe) have prevented its earlier publication. As to when the field-book itself will be published, or as to how much of it will appear in advance in this journal, we are as yet unable to state. It ought to be within the current year at least, and it is now expected to be; but we fear that the author does not keep his "nose to the grindstone" as steadily as he used to do, and the "spare time" of an editor of Engineering News is not very great.—Ed.]

WHICH IS "THE NORTHWEST POINT?"

Sir: Referring to the question by "Quinaielt" in your issue of Jan. 2, in which he asks as to what point was reached on the map shown at the end of the description, which recites as follows: "Beginning at the most southerly end of the lake, thence northerly around the east shore of the said lake, to the northwest point thereof." Now, it would seem that the course was limited to a northerly one, and its location was fixed on the east shore of the lake. Any course around the lake after passing "A" was southerly; and on the west shore, if it had been desired to include the lake only in the survey, they would have properly said: "Thence southerly around the west shore of the lake to the point of beginning." If they desired the course to end at "B," they would have said (if they thought "B" was the northwest point): "Thence following the shore of the lake through its various courses



Correct Map of Quinaielt Lake.

to the northwesterly corner thereof." "B" would be considered the westerly point of the lake, not the northwesterly. Now, as you say, if there is doubt in the description, "intent must govern," and you suggest the

Map of Quinaielt Lake From Rand, McNally & Co., Atlas.

possibility that "the commission or some of their advisers had some vague notion of the form of the lake." They doubtless had, and until the present survey the old maps were considered correct and their guide.

In the statistical atlas of the United States, 1870, ninth census, on Plates III. and XVIII., and on a larger scale in Rand, McNally & Co.'s large business atlas, p. 479, we find the lake, and in the last mentioned atlas (1883) we find the map of the Indian Reservation, as shown in the accompanying tracing. The lake lies with its long diameter nearly north and south, is about ten miles long and nearly three wide. In the light of the map the intent of the description is plain.

The reservation is said to contain 224,000 acres, which, if the map is anywhere nearly correct, it could not do if the survey left the lake at the point "B." The easterly side of the lake is the eastern boundary line of the reservation, and the Pacific Ocean the western.

I do not believe in giving land to Indians, except for burial purposes, and I hate to differ from Engineering News, but I am much interested in similar questions.

Yours truly, John C. Goodridge, Jr.

New York, Jan. 2, 1892.

[Our correspondent's production of this old map puts an entirely different face on the matter. Our former correspondent distinctly stated that there were no old maps in existence, and that the question has but recently arisen. The fact that the United States has, by official publications, shown the boundary line to start from about the most northerly line practically settles that question, and the only equitable effect of more accurate surveys, whatever they developed, would be to start the boundary line from the most westerly of two northerly points had there chanced to be two, which there were not.—Ed.]

TESTS OF VITRIFIED PAVING BRICK.

Sir: Thinking that your readers might be interested in reading the result of a test of vitrified fire brick for street paving, I enclose it herewith, to use if you so desire. When asking for proposals for paving our streets with fire brick we required the bidder to furnish several samples of the brick with which he proposed to do the work. These samples were subjected to rather a hurried though severe test, with the result noted. Finding the proposals offered were not satisfactory, inasmuch as the lowest bidders did not offer the best bricks, we decided to reject all the bids and asked for proposals for furnishing the material, and also separate proposals for doing the work. This method was found to be more satisfactory. The prices noted in the table are those stated in the last proposals f. o. b. at Wilmington.

The crushing strength was taken under a hydraulic ram 10 ins. in diameter, the whole brick being imbedded in moulding sand. This was not as satisfactory as I could have desired, but all time would warrant. In making the test for the wearing of the bricks they were placed in a casting-rattler together with several large pieces of cast iron of all shapes, thus securing the most severe test. Before testing the bricks for absorption they were placed in the top of a burning kiln of bricks and thoroughly dried; immediately after they were placed in water.

Tests of Vitrified Fire Brick for Street Paving, Wilmington, Del. Made Sept. 16, 1891.

A	B	C	D	E	F	G	H
	$	in. in. in.		%	%		
John Porter Co....	18.58	8¾×4⅜×2⅛	2	6.7	4.9	8,100	2.046
West Virginia.....	..	8¼×4¼×2⅛	6	4.1	5.0	8,420	2.1-9
New Brighton ..	21.50	8⅞×4 ×2⅛	9	1.6	3.8	11,170	2.280
Smith, Porter & Co	18.50	8⅜×4⅛×2⅛	11	7.4	12.3	4 740	2.018
New Cumberland.	18.58	8⅛×4⅛×2⅛	17	3.8	4.5	13,180	2.250
N. Y. Paving Co..	.....	8⅛×3⅞×2¼	19	11.5	3.8	5 600	1.870
W. Virginia, No. 1		8⅝×4⅛×2⅛	21	4.1	4.2	.....	2.003
Toronto.....	18.58	8⅛×4⅛×2⅛	23	2.3	5.0	7.700	2.067
Fair Hope.....	..	8¼×4⅛×2⅛	25	2.4	5.5	5,980	2.214
W. Pennsylvania..	..	9⅛×4⅛×2⅛	27	5.7	8.1	7,230	2.0.0
Glade.....	18 75	8⅛×4⅛×2⅛	31	3.5	4.6	7,820	2.200
Trott, (W. Pa.)....	22.50	8⅝×4⅛×2⅛	32	1.8	2.7	.....	2.121
Simmons Porter...	18.58	8⅛×4⅛×2⅛	24	1.5	3.6	10,240	2 080
Minor.....	18.45	8¼×4⅛×2⅛	37	4.4	3.8	8,590	2.052
John Porter:							
Round edges.....	....	8⅞×4⅛×2⅜	39	2.6	4.6	8,240	2.289
Barrington.....	14.00	7⅞×3⅝×2¼	41	0.6	4.0	13.840	2.298
Dunbar Paving Co	9	×4 ×2⅛	28	4.0	...	9.420	2.164
Vulcan Paving Co	18.45	8⅝×4⅛×2⅜	29	4.1	...	7.500	2.111
U. S. Fire Clay Co.		8⅝×4⅛×2½	43	3.9	6.0	10,200	2.086

A, name; *B*, price per thousand; *C*, size; *D*, number; *E*, percentage of absorption after 48 hours in water; *F*, per cent. of loss after 15 min. in rattler, 18×40 in., at 50 revo. per min; *G*, crushing strength in pounds per square inch; *H*, specific gravity.

I would have liked to have had more time and better facilities for making a test, but usually all engineers are pushed for the former and curtailed in the latter. I might say that the various make of bricks accepted by the Board of Directors of the Street and Sewer Department and used upon our streets are the "New Cumberland," made by McMahon, Porter & Co., of New Cumberland, W. Va.; the "Glade," agents, Donaldson, Bros. & Co., Philadelphia, Pa.; the "Minor," made by the John Porter Co., of New Cumberland, W. Va., and the "Barrington," made by the Barrington Steam Fire Brick Co., of Barrington, R. I. Very truly yours,

T. Chalkley Hatton,
Engineer in Charge of Sewers.

Wilmington, Del., Dec. 26, 1891.

AUTOMATIC BLOCK SIGNALS ON THE NEW YORK, PROVIDENCE & BOSTON R. R.

Sir: In answer to your telegram inquiring as to the experience of this road, and of its leased line, the Providence & Worcester, with automatic block signals; our knowledge of the working of the automatic electric block signals on the Providence & Worcester R. R. does not go back of May, 1886, at which time that road was leased by this company. Since that time I recall only one instance of a rear collision on track covered by these signals. The evidence at the investigation of this collision sustained the claim that the locomotive engineer ran by a block signal at danger *and also* a rear flag or lantern in the hands of a brakeman.

This company has, including its Worcester Division (P. & W. R. R.), about 145 signals covering about 90 miles of track, all put in since 1882. This mileage is about 42% of our main track mileage. We have a good opinion of the effectiveness of the signals. We know of a number of instances where these signals have indicated to approaching trains that switches from main tracks to sidings have been carelessly left wrong, and where there have been breaks in the rails, and very frequently the presence of trains in the block has been indicated.

We prefer the "overlap" method of erecting these signals, as this gives two signals in rear of any train when the train is close to the signal just passed. The overlap in our system is about one-quarter of a mile.

This system we believe to be nearly if not quite as reliable as any of the electro-mechanical devices which are controlled by operators in each block. We believe this to be the most reliable automatic system in use.

On our Main Line division, Providence to New London, where we have about 60 signals covering about 45 miles of track the number of which has gradually been increased since 1884, I do not recall a single instance where we have had a rear collision without it has been clearly shown than the engineer ran by signal and miscalculated his ability to stop within the distance, all of which were of small consequence and none of which resulted in fatalities or injuries. I do not know of any accidents caused by failure of signal to work.

We have printed forms for reports of cases of finding signal at danger and all cases are followed up closely, but we have no tabulated statements of same.

About 85% of our block signals are also connected with switches in the blocks, this being our general practice where there are switches.

The cost of the plant has averaged about $500 per signal. I cannot give you the maintenance cost without considerable study, nei her can I tell how many signalmen and switch men are done away with, without more time than I can give just now to the subject.

Yours truly, E. P. Dawley,
Chief Engineer N. Y., P. & B. R. R.

Providence, R. I., Dec. 30, 1891.

THE EQUITIES OF AN OVERHEAD CROSSING CASE.

Sir: The new Detroit branch of the Flint & Père Marquette R. R. (double track, 8.50 miles) crosses the Michigan Central R. R. 2½ miles west of Grand Trunk Junction, overhead, on a deadlevel plain. The crossing was made by using 4,814 lin. ft. of pile and timber trestle, containing over 1,000,000 ft. B. M., with one through span (iron and steel) 110 ft. over all, and one deck girder span 74 ft. over all, at the crossing, mounted on good substantial stone abutments and piers.

Cost of trestle	$25.000
Masonry, 1,100 cu. yds., first class.....	12,000
Two iron and steel spans, 184 ft.....	14.800
Total cost of crossing.....	$51,800

The grades at the crossing are 35 ft. per mile on north side of the M. C. R. R. for half a mile, and 40 ft. per mile on the south side for about the same distance. The Michigan Central double track at the crossing was lowered 3 ft., and the F. & P. M. R. R. was compelled to give 20 ft. headway, which place the base of its rail about 24 ft. above the M. C. track.

Under all the circumstances of this crossing the cost, in my judgment, should have been paid, one-half by each company, but it was adjusted by compelling the old line to pay simply for lowering their track (costing say $6,000 to $8,000), without damage to their grades, which are practically level and obliging the weak party to introduce 35 to 40-ft. grades and spend at least $120,000 before the work is finally completed. Yours truly, Wm. B. Sears.

Saginaw, Mich., Dec. 19, 1891.

This is one of the many crossing cases where the exact equities of the case are hard to discover. Having regard only to the public interest, or the interests of the railway system as a whole, the best thing to have been done in this case, perhaps, might have been to put in a grade crossing protected by the best form of electrically locked interlocking signals. This is not as absolutely safe as an overhead crossing, but it is so much more economical, not only in first cost, but in subsequent hauling capacity, that the slight additional risk may reasonably be claimed to be justifiable, and if accompanied by an absolute right of way to all trains of the older, longer and more important road in case of opposing trains, would have done it little harm.

Still, barring this possibility, which might be plausibly opposed on the ground of increased risk to the heavy traffic concerned, we fail to see anything so very inequitable in the terms of this settlement. So far as the grades were concerned it was eminently proper that those of the Michigan Central should have been left undisturbed, and all the heavy grades concentrated on the new, short and light-traffic branch. So far as the division of expense is concerned, why should the Michigan Central be compelled to bear a part of the cost of constructing the Fint & Père Marquette's road? It is bound in law and equity to grant that road right of way across it, and to obstruct its crossing as little as possible by making any feasible changes in its line which may be legally demanded; but that it should be compelled, after doing this, to put its hand in its pocket and pay out money to help build a rival road over itself seems hardly equitable. The question is entirely different when two roads which have heretofore crossed on a level desire to separate their grades. Then each has vested rights, and each should help to pay the bill in proportion to the benefit received and should be compelled by law to do so.—Ed.]

In testing the newly-finished railway bridge of 295 ft. span across the Danube at Pressburg, Hungary, the spans were first loaded for three hours with 3 heavy engines, 12 loaded gravel-cars, and 1 passenger coach. Finally the train was run over the structure at a slow rate, and at 23 miles and 31 miles per hour. Under this test settling of the structure was noted. The middle span settled 1½-in. and the side trusses (span not stated) ¾ in. After the load was removed the spans rose within ⅛ to ¼-in. of their former level.

STEEL SKELETON BUILDINGS—Z-BAR AND PHŒNIX COLUMNS.

SIR: Mr. Purdy's articles on "Steel Skeleton Type of High Buildings," are extremely interesting, and, I hope, will be read and discussed at length by engineers, as little at this day has been written on this subject, and it is to be hoped that these discussions will bring out new theories and ideas in relation to this class of important work. Mr. Purdy seems to have a decided preference for Z-bar columns; which, to my mind, is not borne out by the arguments he uses, or practice by those who have used them extensively.

Referring to Part II., in your issue of Dec. 12, in relation to the relative strength of different columns, it will be noted that he passes over that point in anything but a satisfactory manner. It is a well known fact that metal near the neutral axis of a column is good for little or nothing, and that the capacity of columns of equal areas varies as the metal is removed from the neutral axis. Under certain conditions, therefore, it can be seen at a glance that Z-bars and Larimer columns will rank after any of the other forms shown, placing Phœnix columns at the head, as in this case the metal is as far away from the neutral axis as possible. Again, any section having a minimum and maximum radius of gyration is not economical for use in a vertical post subject to a single direct load, as the calculations are only based with safety on the minimum radius of gyration. Therefore, the metal represented by the maximum radius of gyration is of necessity disregarded, and the otherwise efficiency of a portion of the section is lost or wasted. This is almost self-evident. Under this argument I would again place first Phœnix, and after that Keystone columns, with Z bar columns as considerably less economical and efficient in arrangement of section.

Unsupported flanges are still another very important thing to be considered in the columns. Unless a column having long flanges is used in very short lengths, the columns must necessarily be weak in the flanges and fail by wrinkling. As Mr. Purdy recommends Z-bars especially for small columns, he must necessarily use them without covers. Under this condition they are the weakest of any of the forms of columns shown. I do not consider that these points are things that should be overlooked, and they are not necessarily "hair splitting" arguments. If he will refer to tests made on full size columns he will find that the statements made are borne out by facts, and that Phœnix columns are the strongest form of strut yet designed.

In designing a bridge Mr. Purdy would not think of getting out the compressive strains in chords and posts due to engine loads and then, in designing his sections, overlook the relative advantage gained from different sections by a greater radius of gyration. Now if an engineer designing a bridge would not overlook these points, why should an engineer in designing a building, where there are hundreds, and in some cases thousands, of columns to be taken into consideration, while in a bridge there are practically few, or at least only a part of the members under compression, and where the radius of gyration to the lengths of the columns is often less in buildings. Take for instance the Hotel Majestic, Seventy-second St. and Eighth Ave., New York City, now in course of construction. This building has about 160 columns on a floor 10 stories high, or over 1,600 columns to be figured. Here the saving by using the most economical section will amount to a considerable number of tons, and to thousands of dollars in expense.

In the early part of the paper he states: "However, when the ratio of the radius of gyration to the length of the columns is as small as it usually is in building construction, rarely over 70 radii, the difference in the strength of the different sections tends to disappear, and the question of relative strength is of less consequence. Any of these sections in an ordinary building column will carry the load safely, with the unit strains ordinarily used, if the column is well made, and the loads are symmetrically applied, but the great trouble is that either of these conditions may be wanting in actual practice." Later on in speaking of eccentric loading he states: "In some of our Chicago buildings this matter is thoroughly studied with a view to obtaining the utmost efficiency of the material used." Now does this not look like evading a mountain and examining a mole-hill with a microscope?

In relation to the points, of which there are eight, that Mr. Purdy names as important for this class of structure:

Point I, "Cost." Z-bars are probably as difficult a section to roll as imaginable, on account of the trouble to get the bar perfect and full in the flanges, and further, to get it straight after being rolled. Any of the other forms would be cheaper to roll than the Z-bar. While the Z-bar columns without covers have less lines of riveting than other columns, except the Larimer, still the difficulty mentioned above to keep the column straight is very great. As an instance, 19 out of 20 Z-bar columns, and then 8 out of 15 subsequently shipped, completing the same job were rejected on account of being too crooked, making in all 35 columns out of which there were 27 rejected on this account. The difficulty in straightening even the most symmetrical and the less complex sections after cooling is well known to every iron mill. Not only is the Z-bar more certain to curl, but it is prone to twist in more intricate convolutions than simpler forms. This, perhaps, would not be so serious an objection if it were possible to straighten it after cooling or again after punching, which of one leg or of even two legs will invariably curl it more. It is not, however, practicable economically to straighten the Z-bar. It is, of course, true they may be made practically straight, but not as a commercial product. Any one familiar with the process of straightening even ordinary mill sections will see the reason for this at a glance, also how difficult it is to "get hold" of such a shape and on taking out a curl, a sweep or a bend, how certain it is to find a new one has been started somewhere else. The importance of this can hardly be overestimated. All the close assumptions and fine drawn conclusions relative to the Z-bar columns, especially as figured in the West, are based on a theoretically straight and plumb column. If either or both of these conditions are not preserved (and the one may readily involve the other) of how much value are the calculations? Looking at it from the attitude of any common sense architect or builder, does not this one fact vitiate at once the calculations for safety? These considerations would practically dispose of points one and three.

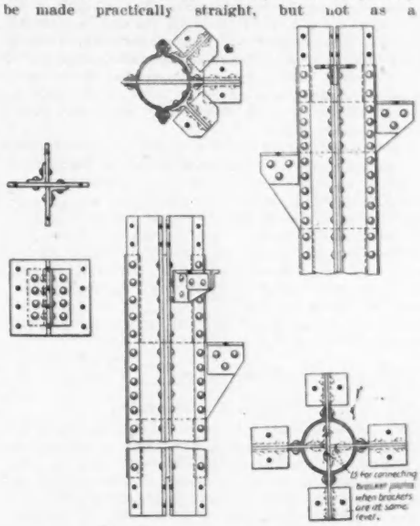


Fig. 1. Fig. 2.

Cross Pintle Connections, Giving Continuous Phœnix Columns from Bottom to Top of Building; Also Showing Detail of Brackets for Girders and Floor Beams at and between Joints in Column Segments

(This style of construction was used throughout the 10-story fireproof Washington Loan and Trust Building, at Washington, D. C.)

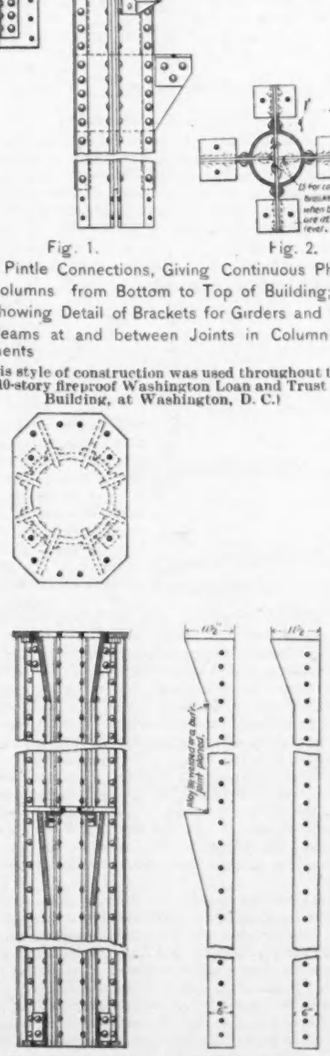


Fig. 3. Phœnix Columns With Extra Flange Plates.

(Section consists of 8 segments 1⅜ in. thick = 92.0 sq. in.
8.6 in. × 1⅝ in. filler plates..... 66.0 "
158.0 "

(Flange plates varied for intermediate section).

Under point 2, "Availability." Of course, the plate and angle columns lead all the rest, as they can be supplied by any number of concerns.

Point 4, "Means for applying the loads as closely as possible to the axis of the column." Of course, in a Z-bar column this must necessarily be done, because if the load is applied to the unsupported flanges they will fail, but in a Phœnix column this is not necessary. We will suppose first that in the Phœnix column the load is applied to the shell of the column at one side. This load will travel around the column and downward at an angle of about 45°, so that, at a distance below the load equal to the diameter of the column, the whole column will receive an equal load on all parts. Now consider the load as applied at the flange of the column. By reference to the numerous connections shown in the book on Phœnix columns published by Milliken Bros., it will be seen that there are several general methods of making connections to the flanges. In some cases, where filler bars are used between the flanges, the load can be transmitted directly to the opposite flange by means of a gusset plate (see Figs. 1 and 2) or the filler bars can be forged out to form a connection (see Fig. 3). In a 4-segment column four loads can be used at the four connecting flanges, or in a 6-segment column six, or in an 8 segment column eight, and there is hardly a case happens in which the load cannot be brought directly to a supported flange. This is all in addition to the loads which can be taken on the shell direct at any point or in any direction. In a Z-bar column, or in a square column, or in any other form of column, excepting the Keystone column, it is impossible to do this. In the event of using cap plates and brackets for carrying floor loads then one column is as good as the other. There is a decided advantage in using flanged filler bars as shown in Fig. 3, owing to the fact that the load intended to be carried by the bar is brought by the bar and carried by it, while bracket connections used in the ordinary Z-bar columns depend solely for their support on the shear of the bracket rivets. In order to make a first class connection the bracket holes must fit the holes in the column exactly, and the rivets must completely fill the holes, a case which which rarely occurs, even when the greatest care is used. In order to carry any great load the bracket must necessarily extend a great distance below the seat, in order to get enough rivets in to take the shear. This is not the case with the filler bar construction.

Point 5, "Convenience for connection." This point in connection with the Phœnix columns presented a number of difficulties in their early use, but these points have been so well studied out that the forms of connections are now innumerable. By means of cross pintle connections for instance (see Figs. 1 and 2), it is possible to make a continuous column from the basement to the roof, in which the joints are actually stronger laterally than the column itself and the connections are practically about one-half the weight of the usual form of base plates and brackets used in other constructions.

Point 6, "Convenience for providing eccentric loading." This point, and Point 7, "The relation of size to connection of small column" have already been answered.

Point 8, "Relation of section to fire proofing." This, I think, is of more importance than Mr. Purdy seems to place on it. The objection that architects generally urge against cast iron columns, other than their liability to fail, etc., and their actual strength, is their size. It is not always possible to enclose columns in the walls, and where they are exposed it is often desirable that they be fire proofed. In doing this it is desirable to keep the columns as small as possible, on account of their appearance and their occupying space in the room. They are generally fire proofed, so as to make them circular in section, and in order to do this with a Z-bar column there is not only additional expense incurred in waste of fire proofing, but the column is unnecessarily large. This is not the case in a column of circular section.

Mr. Purdy makes no mention about the method of increasing the section of Z-bar columns after the limits of the Z-bars themselves have been reached. Of course, this is done in the usual way by adding plates or angles to the section. This will increase the radius of gyration, and consequently the carrying capacity in relation to one axis considerably, but in relation to the other only very little. This is certainly not economical. Now the case with Phœnix columns is just this: After selecting the segment intended to be used, filler bars are inserted between the flanges to make up the required section. These filler bars increase the diameter of the column, and in increasing the diameter they increase the capacity of the segments themselves and that of the filler bars. They therefore do a twofold duty. This is very clear, as the radius of gyration of a Phœnix column equals the diameter (outside shell) × .3536. The moment that you increase the diameter you increase the radius of gyration, and therefore the unit stress per square inch.

Mr. Purdy states where Z-bars are used, but only refers

to Chicago buildings. Now if Mr. Purdy will turn his attention from Chicago, where he must admit that Z-bars have been "pushed" more than other forms of columns, he will find that, in New York for instance, there are over ten buildings using Phœnix column construction to one where Z-bars are used, and this case exists, possibly in smaller ratio, with reference to smaller cities in the United States, outside of the city of Chicago. In the city of Chicago I believe that the Phœnix columns are used in the Cook County Abstract Building, Board of Trade, German Opera House, Chicago Illuminating Co.'s power house, Gormully & Jeffery Building, W. D Ewart Building and in the American Express Co.'s new barns, only one of which Mr. Purdy mentions. To give some idea of the size and capacity of the Phœnix columns, I would state that in the German Opera House there are columns which are 92 ft. 10 ins. long and which weigh over 25,000 lbs. each. It is not uncommon to have 800 tons and over on a single Phœnix column, or to have 158 sq. ins. in the section. In a case of this kind I cannot see where Z-bars would be of the least possible service. The poor little Z-bars would be entirely lost in a mass of plates.

Referring to part III, in your issue of Dec. 26, Mr. Purdy gives certain unit stresses which I consider entirely too high. For instance, he mentions 15,000 and 20,000 lbs. without any reduction for length of columns. Now if you will refer to part II you will see that after taking the live floor load he only allows one-half of same on the columns, assuming that only one-half of the floors will be loaded at any one time or that only one-half the live load will ever occur on all the floors at one time, the result being the same in either case as far as the lower columns are concerned. Now we will assume a case of a lower column. Generally the first story columns are the longest and we will suppose them to be 28 ft. long, which is not at all unreasonable. The stress as he gives it is 20,000 lbs. per sq. in. The live load is as he gives it about 50% of the entire load (average about 100 lbs. live and 100 lbs. dead for the Fair Building). Then 6,667 lbs. per sq. in. represents the stress for the live load, and assuming the entire live load to come on the columns the additional stress per square inch will be 6,667 lbs, more, or a total of 26,667 lbs. instead of 20,000 lbs. on which he figured.

Referring now to the table of tests of full size Z-bars mentioned by Mr. Purdy we find that the ultimate capacity or breaking load of a Z-bar column was 27,600 to 28,000 lbs. per sq. in. for 28 ft., the length taken. Now I admit that the tests were on lattice web and not solid plate, and that it is seldom that all floors will be fully loaded, but taking all this into consideration I will leave it to any reputable engineer if such construction is not only faulty but absolutely dangerous in having a possible load on a column so near its ultimate capacity. If uneven settlement should take place there is every indication that such a column would give way. Let me refer to a mill handbook on Z-bar columns which says: "It is to be noted that the allowable stresses were assumed at 8,000 and 10,000 lbs. per sq. in. respectively for lengths of 90 radii and under." Still Mr. Purdy essays to use double these values. Now let us consider his floor loads to see if they are excessive. I quote as follows from the Fair Building, the assumptions in which he states are very heavy: "The 1st, 2d, 3d, 4th and 6th floors are made to carry 130 lbs. per sq. ft. of live load the 5th to carry 200 lbs., the 7th and 8th floors to carry 100 lbs. and the other eight floors each to carry 75 lbs. All this is in addition to the dead loads." I quote as follows from the Venetian Building. "The live loads on these floors have been taken at 35 lbs. per sq. ft. On the 2d, 3d and 4th floors it is taken at 60 lbs. and on the first floor at 80 lbs." The practice of the department in New York is as follows; I quote from the Building Law, Paragraph No. 491: "In all buildings, every floor shall be of sufficient strength in all its parts to bear safely upon every superficial foot of its surface 75 lbs.; and if used as a place of public assembly, 120 lbs.; and if used as a store, factory, warehouse or for any other manufacturing or commercial purpose, from 150 lbs. and upwards; and every floor shall be of sufficient strength to bear safely the weights aforesaid, in addition to the weight of the materials of which the floor is composed; and every column, post or other vertical support shall be of sufficient strength to bear safely the weight of the portion of each and every floor depending upon it for support, in addition to the weight as required as above to be supported safely upon said portion of said floors." You will note that no deduction is made in calculation of the live loads on either girders or columns upon the assumption that all floors can never be loaded at one time. I should say therefore that Mr. Purdy's loads are insufficient. This would make the case all the worse. It is not an uncommon thing to have floors here even with a live load of 600 lbs. Take for instance the loads of a building I happen to have before me, the Fire Department Building in Brooklyn, now in course of erection. 1st floor, 400 lbs., 2d and 3d, 200 lbs., 4th, 250 lbs., 5th, 200 lbs. and roof 150 lbs.; all live loads, and yet this is not such an exceedingly heavy building. The first floor is used for fire engines and the fourth for squad drilling, but the others are only for ordinary offices. I called attention in the previous part of my letter to the use of Z-bars for large columns. Let us examine the largest Z-bar column yet used, mentioned by Mr. Purdy, namely, and 4 Z-bars 6 × ⅝ ins., equals 40.4 sq. in.; 2 web plates 16 × ⅜ ins., equals 24 sq. ins.; 6 cover plates 16 × ½ ins., equals 78 sq. ins., or out of a total of 142.4 sq. ins., only 40.4 sq. ins., or less than 30% are Z-bars, the balance being plates. Has this 30% of material added anything to the capacity of the plates or to the form of section? Could not angles or some other shape be used to better advantage than Z-bars? I am quite sure it could. Or take again the large column for Venetian Building shown. The argument used for Z-bars is that they have but 2 lines of rivets while here we have no less than 12. This is 4 more than are required in a box column, and 4 more than are required in the largest Phœnix column, either of which would give a stronger column of equal area.

I must apologize for taking up so much of your valued space, but I hope that that this may bring out the opinion of others and settle for building work, as it is now practically settled for bridges: First, the proper loads to assume; Second, the proper factor of safety and unit stresses to be used in designing this work, and, Third, the safest and most economical form of columns to use. Architects, who generally have these matters in charge, depend on information from such sources as your valued paper, as they have not time to study it out for themselves. If you can be the means of bringing this about, you will, I know, confer on them a great favor.

Foster Milliken.

New York, Dec. 29, 1891.

NEW COLUMN SECTIONS.

Sir: As an appendix to the very interesting article on "The Steel Skeleton Type of High Buildings," by Corydon T. Purdy, C. E., in Engineering News of Dec. 12, 1891, allow me to introduce the following column sections on which I lately have obtained a United States caveat.

The principal features of these sections, as I regard them, are as follows: The increase of thickness in the

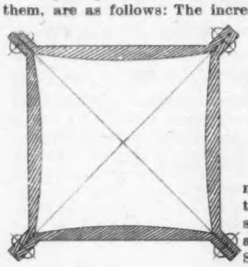


Fig. 1.

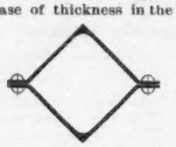


Fig. 2.

middle, half waybetween the flanges, imparts strength to the column and admits of the sides S being rolled to very large dimensions. The strength obtained in the Phœnix and Keystone columns by curving or bending the surface, I obtain by swelling the material on the inside, not enough, however, to give an insufficient support for rivet or bolt heads. The moment of inertia is very large and the material is uniformly distributed. The sections shown in Figs. 1 and 2 seem easier to roll than ordinary channels, because the flanges are bevelled. The cost of these columns should be comparatively low, on account of their economical and practical form. They can be used to advantage in brick walls, as the flanges will act as anchors to hold the masonry in place. The loads can be brought comparatively near to the center or axis of the column, inasmuch as beams or girders can be placed between the flanges, in a similar way as to Z-bar columns with plates. By rolling one or two sides heavier than the others, the column can be made stronger in one direction.

As Mr. Purdy states, the question of connections is constantly becoming more important, and it was chiefly a desire to construct a column that should meet the requirements of theory, economy and simplicity of connections, that led me to devise these sections. Comparing them with the Phœnix and Keystone columns it will be admitted that the material is as well distributed as in these two types; and that regarding connections, my columns are superior, besides having the advantage of being square. Compared with the Z-bar columns mine have two advantages: that of better distribution of metal and their relation of fire-proofing.

The above remarks present my views regarding these column sections, and I shall be very thankful to any engineer for a response or criticism, as I am desirous of learning whether or not my claims are correct.

Respectfully yours, E.

New York, Dec. 22, 1891.

MILD STEELS FOR STRUCTURAL PURPOSES.
II. BASIC STEELS IN GERMANY.

By Gus. C. Henning, M. E.

The following is abstracted from a paper by Prof. R. Krohn, Chief Engineer of the Gutehoffnungshuette in Sterkrede, at which place extensive tests of mild steels were made for the German State Railways under the supervision of Messrs. Leonhardt, Bassel, Boisserie and Carstayen, prominent German engineers.

The specifications for steel originally in use in Austria and Germany were copied more or less closely from those used in England and America, where this material had been used much earlier and more generally. In physical requirements especially, these specifications had been followed; and this was rather unfortunate for Germany, whose iron ores are particularly adapted for the production of very soft basic steel. Higher carbon steel can be made by using the open-hearth process; but the product has proved to be less uniform and reliable. The basic open hearth process in Germany produces a steel having a tenacity between 52,620 and 62,570 lbs. per sq. in., and this may be termed the natural tenacity of basic steel. While stronger metals may be produced by adding to the percentage of carbon, a greater number of charges will be found not to fulfill the requirements, and as mistakes will occur, even with the greatest care, the possibility of poor metal finding its way into a structure is increased. It therefore seems judicious for the engineer to call for nothing above the natural tenacity. Another consideration of even greater importance is that harder steels of higher carbon are much more liable to injury during manipulation, and are more affected by changes of temperature. It is in these important respects that the soft basic steels particularly commend themselves to the engineer, being much superior even to wrought-iron in their ability to withstand rough treatment without injury. The tests by which this important fact was conclusively proved to the satisfaction of all the engineers taking part in the investigation were as follows:

Two grades of wrought-iron and two grades of basic open-hearth steel were procured. One grade of the iron was rolled from scrap piles, the other from muck-bar piles. The tenacity of one grade of steel was about 68,000 lbs. per sq. in., while the other was a softer steel with a tenacity of about 54,000 lbs. per sq. in. The results given in the following cases are in every instance the average of three different tests. When test pieces of different workmanship are compared, they have invariably been taken from the same rolled bar in order to avoid, as much as possible, differences in the material.

Table I.—Tension Tests on Pieces Cut from Rolled Shapes and Carefully Planed and Filed.

Material.	Tenacity. Lbs. per sq. in.	Elongation in 8 ins. %	Contraction of area %	Relative resilience *%
Scrap iron	54,660	21.1	24.7	811
Muck bar iron	54,700	13.8	15.2	530
68,000-lb. steel	69,480	23.0	40.8	1,119
54 000-lb. steel	54,620	29.8	60.0	1,144

* Actual resilience is the total work done in breaking a specimen. For convenience a relative resilience which is closely proportional to the actual resilience is used instead. It is obtained by multiplying the ultimate strength by the percentage of elongation. The figures given throughout this article for relative resilience are those computed from the metric units, the tenacity being given in kilograms per square millimeter and the elongation percentage in a length of 200 mm. Since a strain of 1 kg. per sq. cm. corresponds to 1,422 lbs. per sq. in., the relative resilience based on the English units would be 1,422 times that given above.

A second series of tests were then made on pieces similar to the above, but cut from the plates by shearing, and trimmed with the chisel, instead of being planed and filed as in the former case. The results are shown in Table II., the last column giving the percentage of decrease in relative resilience consequent upon the rougher treatment of the test pieces. The great injury to the iron and the comparatively little loss in resilience of the steel is evident at a glance. The slight increase of tenacity is due probably not to the influence of sheared edges but to the smaller percentage of contraction, giving a larger section to be ruptured at the moment of failure.

Table II. Tension Tests on Pieces Sheared from Rolled Shapes and Trimmed with Chisel.

Material.	Tenacity, lbs. per sq. in.	Elongation, ¼ in 8 ins.	Contraction of area, %	Relative resilience, %	Loss in relative resilience, %
Scrap iron	51,480	9.3	11.7	236	38.5
Muck-bar iron	48,700	5.1	6.6	174	67.2
68,000-lb. steel	70,000	21.0	36.3	1033	7.7
54,000-lb. steel	55,140	28.1	55.9	1089	4.8

The third series of tests was made on test pieces planed and filed, as for the first series, but bent to

Table IV.—Tension Tests of Planed and Filed Pieces with Punched and Drilled Holes.

Material.	Ultimate Strength, lbs. per sq. in. Uninjured Material.	Drilled centrally.	% loss or gain.	Punched centrally.	% loss or gain.	Drilled eccentrically.	% loss or gain.	Punched eccentrically.	% loss or gain.
Scrap iron	54,650	52,060	−2.9	43,130	−21.1	51,240	−6.2	45,800	−16.2
Muck bar iron	54,690	51,920	−5.1	45,990	−15.9	51,780	−5.3	47,050	−14.2
68,000-lb. steel	69,200	75,990	+9.8	67,350	−2.6	73,220	+5.9	67,520	−2.4
54,000-lb. steel	54,620	57,410	+5.1	55,130	+0.9	55,570	+1.8	52,260	−4.2

an angle of 50° and straightened again before testing. Table III., which gives the results, shows again the superiority of the steel to the iron in enduring rough treatment.

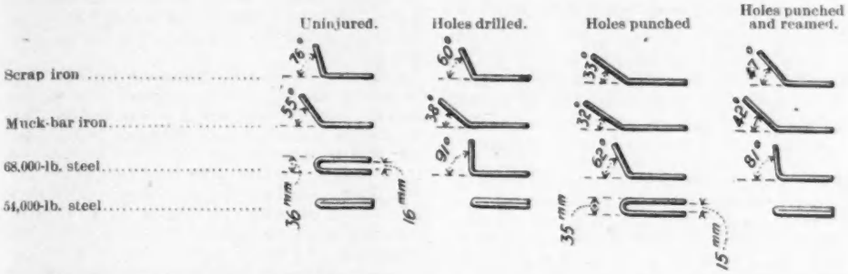


FIG. 1. BENDING TESTS TO DETERMINE EFFECT OF ROUGH TREATMENT ON WROUGHT-IRON AND BASIC MARTIN STEEL.

Table III.—Tension Tests on Planed and Filed Pieces, bent 50° and Straightened before Testing.

Material.	Tenacity, lbs. per sq in.	Elongation, % in 8 ins.	Contraction of area, %.	Relative resilience, %.	Loss in relative resilience, %.
Scrap iron	54,540	13.8	19.7	529	34.7
Muck bar iron	55,500	10.6	12.3	414	21.9
68,000-lb. steel	71,540	19.5	37.6	981	12.3
54,000-lb. Steel	54,900	23.9	56.2	923	19.3

The fourth series of tests was made on specimens having holes through them, some punched and some drilled. Of course the reduction of area and elongation under these conditions could not be compared with the figures recorded in the preceding tests. The tenacities alone can be compared; and Table IV. shows the results which were obtained, with the loss or gain per cent. over the tenacity recorded for the test piece before injury. As before, each value is the average of three tests.

The tests recorded in Table IV show again the superiority of low steel to wrought iron, the latter metal being injured very seriously by drilling and punching, while the steel stood the treatment with very little harm, showing indeed an apparent increase in its unit strength, which is to be explained, however, by the greater area of the fractured section, due to the smaller reduction of area, when the piece broke through a hole.

To further determine the effect of punching or drilling on the different materials, a series of bending tests were made. Strips of each material about 0.39 in. thick were bent with a screw machine, the bending continuing until the first cracks appeared on the tension side of the test piece. Such pieces as bent double without giving evidence of failure were closed down under the hammer. The accompanying cut, Fig. 1, shows the result of these tests, and pictures, in the clearest possible manner, the superiority of the steel to the wrought iron. The toughness and ductility of the softest steel as compared with that of greater tensile strength is also noteworthy.

As a final and conclusive test of the relative resistance of the different metals in actual service under different methods of workmanship, six riveted plate girders were made and tested to destruction. Two of the girders were of wrought iron of about 51,200 lbs. tensile strength, two were of basic Martin steel of about 54,000 lbs. tensile strength, and two were of basic Martin steel of about 68,200 lbs. tensile strength. One girder of each material was built with sheared plates; and the rivet holes were punched and the drift pin was used in assembling the members, as usual in ordinary shopwork. The riveting was done by hand. The other three girders were built in the most careful manner. All rivet holes were drilled, and in assembling the pieces any inaccuracies were corrected by reaming. A hydraulic riveter was used.

All the girders had the same dimensions, being built of a web plate 0.395 ins. thick and 14.4 ins. wide, four angles 3.16 × 3.16 × 0.48 ins., and two cover plates 8 × 0.39 ins. The testing was done in a hydraulic press and the appearance of the girders after failure is shown in Fig. 2. As the loads were calculated from the gage readings alone, and no correction was made for the friction of the hydraulic apparatus, the actual loads probably differed considerably from those given. The value of these tests lies in their determination of the relative strength of girders of different materials and of the effect of careful workmanship in increasing strength. Table V. shows for each girder the breaking loads per sq. in. at the section where greatest strain occurred, and the total deflection.

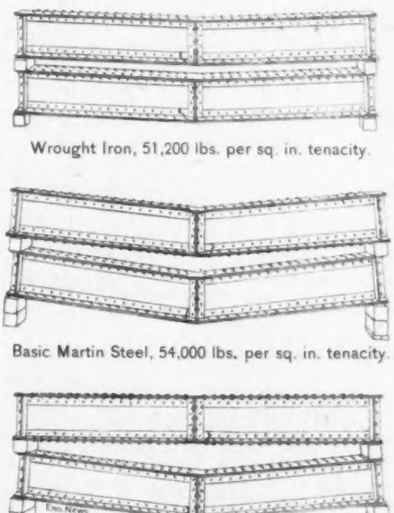


Fig. 2. Tests of Full Size Plate Girders of Various Materials. Each Upper Girder of Good Workmanship. Each Lower Girder of Ordinary Workmanship.

Table V.—Breaking Strains and Deflections of Full-Size Plate Girders.

	Workmanship.	Computed strain at failure, lbs. per sq. in.	Total deflection, ins.
Wrought iron	poor	48,800	1.037
" "	good	47,200	1.087
68,000 lb. steel	poor	45,780	0.089
" " "	good	57,650	5.119
54,000 lb. steel	poor	48,800	2.787
" " "	good	49,570	4.713

According to this test, the wrought-iron girders were but little injured by the poor workmanship, and the same was true of the girders of softest steel, although the deflection of the latter was much greater in the girder of good workmanship. The difference in the strength and elasticity of the girders of harder steel due to the difference in workmanship is remarkable, and conveys an impressive lesson to engineers who use high tension steel for structural purposes. Of course it is to be remembered that while these tests deserve careful examination, being on full-size structures, they are at the same time only single tests and less implicit reliance is to be placed on their results than on the work on test specimens recorded above, where all records given are averages of three tests. The fair conclusion from all the foregoing tests is that soft basic open-hearth steels are less injured by poor workmanship than is wrought-iron. The harder steel, however, as shown particularly by the bending tests and those on full-size girders, does not remain trustworthy under poor workmanship.

WORKING IRON AND STEEL AT A BLUE HEAT.

To determine the effect on the different materials of working at a blue heat, another series of tension tests were made on specimen pieces, which before straining were brought to a blue heat, bent to an angle of 50° and straightened, and then, after cooling, were tested in the same manner as the pieces whose results are given in Table I. The following table (VI.) shows that wrought iron sustained more injury by working at a blue heat than the low steel of either grade tested.

Table VI.—Tension Tests on Pieces Bent and Straightened at a Blue Heat.

Material.	Tenacity, lbs. per sq. in.	Elongation, % in 8 ins.	Contraction, %	Relative resilience.	Decrease of relative resilience. %
Wrought iron.	50,930	6.5	9.7	233	−56·0
68,000-lb. steel.	71,060	16.5	41 6	829	−26·0
54,000-lb. steel.	54,980	20.6	59.6	796	−30·4

It was next decided to investigate the effect of bending angles for brackets and stays at a blue heat. The blue heat was maintained by returning the piece to the furnace at frequent intervals, and the test pieces were cut from that leg of an angle which remained in the same plane. At the same time tension tests were made on pieces cut from the angles before treatment. The results, given in tables VII., VIII., show that all the materials were materially injured by working at a blue heat, but that the injury increased with the tensile strength of the steel, and was even more with the wrought iron than with the stronger steel.

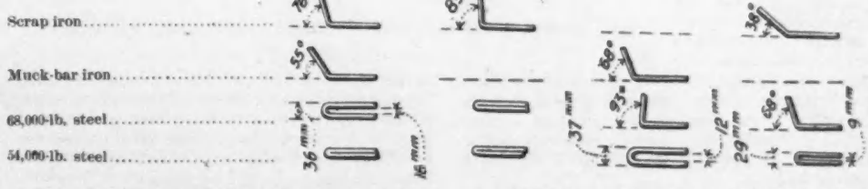


FIG. 3. BENDING TESTS TO DETERMINE EFFECT OF WORKING IRON AND STEEL AT A BLUE HEAT.

Finally another series of bending tests was made, the results of which are shown in Fig. 3. It became apparent that there was a difference in the effect on the material when brought to a blue heat and worked, and when brought to a red heat, cooled to blue heat and then worked. The injury was much greater when the metal was merely warmed to a blue heat than when it reached a blue heat by cooling down from redness.

Table VII.—Tests of Pieces Cut from Angles.

Material.	Tenacity, lbs. per sq. in.	Elongation, % in 8 ins.	Contraction, %.	Relative resilience.
Wrought iron.....	53,610	17.0	18.3	641
68,000-lb. steel.....	71,920	23.2	42 9	1,173
54,000 lb. steel.....	56,440	22.6	46.3	897

Table VIII.—Tests of Pieces Cut from Angles Which Had Been bent at Blue Heat:

Material.	Tenacity, lbs. per sq. in.	Elongation, % in 8 ins.	Contraction, %.	Relative resilience.	Loss of Relative resilience, %.
Wrought iron..	52,500	9.9	18.8	365	43.0
68,000 lb. steel..	72,600	14.2	40.9	724	38.3
54,000 lb. steel..	59,500	16 2	47.5	676	24.6

Comparing column 4, Fig. 3, with column 3, Fig. 1, it is found that the angles to which the material could be bent are identical, showing thus no difference in the results when metal is punched at a blue heat and when punched cold. Neither did bending at a blue heat after cooling from a red heat produce any different results from those obtained in the coldbending tests. But when the pieces were raised to a blue heat and then bent, the harder steel showed a decided increase in brittleness, although no such effect was noticeable in the case of wrought iron or the soft steel.

Summing up, the conclusion from all the tests made is that working at blue heat has a decided influence on all materials tested, the injury done being greater on wrought iron and harder steel than on the softest steel. The fact that wrought iron is injured by working at a blue heat was reported by Stromeyer, of London, in "Naval Professional Papers," 1887.

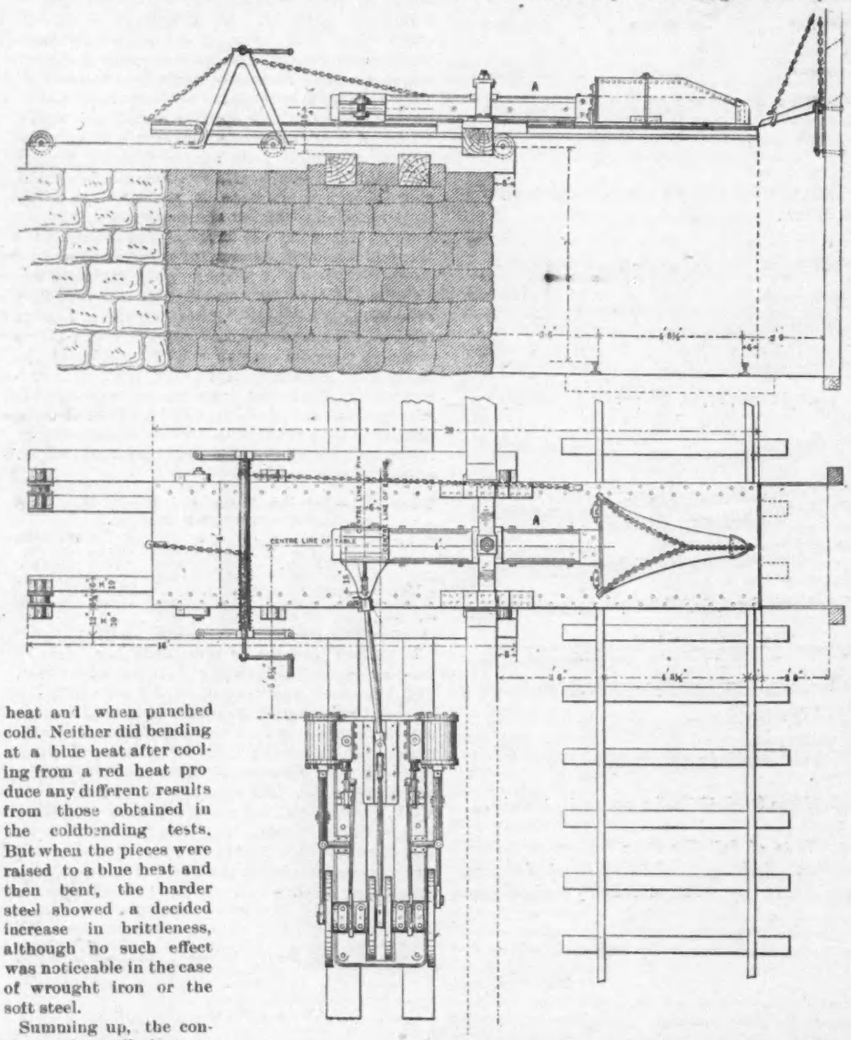
All these tests serve to confirm the opinion that soft basic open-hearth steel of 52,600 to 62,000 lbs. per sq. in. tensile strength, is the most suitable for structural purposes, as it suffers least from indifferent workmanship or ill treatment and is produced with greatest uniformity. It may be said that the foregoing investigation did not include tests under impact or live load, but since the mild steel was shown to be superior in resilience, or in the foot pounds of work necessary to cause fracture, we may safely conclude that this material will be most reliable to carry live loads.

It is often urged against the use of low steel that it has no advantage in actual use over wrought iron, since its ultimate strength is about the same as the strength of wrought iron and it cannot therefore be trusted to carry greater unit strains. But this is an erroneous view, for the elastic limit of steel is always considerably higher than that of wrought-iron, and its percentage of elongation is much greater, so that higher working loads can with safety be permitted, as will be more fully explained further on.

[To be continued.]

THE RAMSAY COAL DISTRIBUTOR.

Throughout the United States, but especially in the West, box cars are very largely used for carrying coal; and they would doubtless be used still more but for the necessity of shoveling the coal by hand in loading the cars at the mines. Box cars have the advantage of protecting the coal from injury by exposure to the weather during transit, and the cars after being unloaded can be used for grain or other merchandise, and do not have to be hauled long distances empty as do special dump cars. Whether the hopper-bottom car or the box car is the more economical for carrying coal depends solely on the length of the haul. The advantage in using the hopper-bottom car is the saving in cost of loading and unloading; and if the haul is short, as from the mines to the chief shipping points on the Eastern anthracite carrying roads, the saving is a very important one. On the other hand, if a car is to make a journey of a thousand miles after loading, the saving made in loading and unloading by the use of the hopper-bottom car is comparatively unimportant; and unless this type of car can be used for some return shipment, such as iron ore, the box car is the more economical.



THE RAMSAY DISTRIBUTOR FOR LOADING BOX CARS WITH COAL.

It is quite true, however, that at the present day the shipper of coal, and of other commodities as well, takes thankfully such cars as he can get, while the railway furnishes him whatever it can most easily lay its hands on. Thus it comes about that coal miners in the far West have to make practically all their shipments in box cars; and the cost of shoveling the coal is quite a serious tax.

We illustrate herewith a simple machine for loading coal in box cars, which has been introduced at several prominent Western mines, and has given excellent satisfaction for loading both box and gondola cars.

It consists of a vibrating beam carrying a sheet iron "nose" on one end, the opposite end being worked to and fro by a double-acting steam engine. This mechanism is placed close to the track on the opposite side from the loading chute by which the coal is delivered to the cars. The car to be loaded has both doors opened and the distributor is run foward into the car, while the chute on the other side is adjusted to deliver the coal directly on the nose of the distributer. As this is rapidly vibrated to and fro, it throws the coal to either side, depositing it in the ends of the car. In practice it is found that the engineer can control the distribution of the coal very perfectly by regulating the speed of the engine, piling it first in the extreme ends, and as the car fills letting the coal fall nearer the center.

It might be expected that this machine would break the coal and cause an increase in the amount of slack; but in practice it is found that the breakage is less than when the coal is loaded by hand shovelers. Among other advantages, are the thorough mixing of the fine coal with the coarse, the placing of the bulk of the load over the trucks instead of over the center of the car, and an increase in the capacity of the shaft or slope without increas the number of chutes. The machine, with one attendant, will load 100 box cars in 10 hours.

The distributor is driven by a double engine, as shown in the illustration, having two 10 × 12-in. cylinders. The vibrating beam is mounted on a stiff timber frame, which is moved backward and forward on rollers in the foundation by means of a windlass. A steam cylinder is provided for moving the frame if desired; but its use is not general. The distributor weighs 6,750 lbs., and the engine 6,650 lbs. The price of the distributor and engine, f. o. b. at Ottumwa, Ia., is $1,400.

Our attention was first called to this machine by Mr. Delos A. Chappell, President and General Manager of the Victor Coal Co., of Trinidad, Colo., who informs us that the use of this machine has not only greatly reduced loading expenses at the Victor mine, but has more than doubled its output, which was limited by the slow process of distributing the coal with hand shovels at the loading chutes. This is an excellent illustration of a general rule, whose importance many engineers learn through disastrous experiences, that the success or failure of an enterprise often turns upon small and apparently unimportant details. It is the little easily overlooked particulars which most often bring to naught "the best laid plans of mice and men."

The inventor of this machine is Mr. Richard Ramsay, of the Braceville, Ill., Coal & Coke Co. It is made and sold by the Ottumwa, Ia., Iron Works.

SHIP TRANSPORTATION AND THE CHIGNECTO SHIP RAILWAY.

At the meeting of Dec. 29 of the Canadian Society of Civil Engineers, Mr. H. G. C. Ketchum, Chief Engineer of the Chignecto Ship Railway, presented two papers relating to the above subjects. An interesting historical sketch of the conveying of ships across necks of land forms a preface to the first paper. In this preface ship transport is shown to date back to the works at Diolcus on the Isthmus of Corinth. These works existed in the days of Aristophanes, 427 B. C., and are said to then have been in operation 300 years. The name Diolcus is derived from the Greek verb "to drag," and vessels 149 ft. long, 18 ft. wide and drawing 8½ ft. of water are said to have been conveyed by means of a tramway from the harbor of Schœnus to Port Lechœum. The Greeks, in 831 A D.; the Venetians, in 1438, at Lake Garda, and the Turks, in 1453, at Constantinople, used tramways for the conveyance of vessels across

intervening land. Coming nearer to our own date we have the Portage Railway of 30 years ago, connecting the canal systems of East and West Pennsylvania across the Allegheny Mountains, and somewhat similar construction on the Morris and Essex Canal, in New Jersey, and the Bude Canal in Cornwall, England.

In 1830 Sir James Brunlees and Mr. E. B. Webb proposed a ship railway across the Isthmus of Suez, which plan was referred to M. de Lesseps and rejected by him. According to their plan the railway was to be level, with 10 rails carrying an iron cradle for the ships. The speed was to be 20 miles per hour, and the estimate of cost was one-seventh of that for a canal. The hydraulic lift of Mr. Edwin Clark, M. Inst. C. E., was to be used for raising and lowering the ships. This lift was first used at the Victoria Docks, London, and this invention renders ship railways possible anywhere where canals have been projected.

The paper of Mr. Clark, read before the Institution of Civil Engineers in 1866, led Mr. Ketchum to turn his attention to the improvement of the Baie Verte Canal by conveying large vessels on pontoons through a shallow canal. The author found it difficult to work out his problem at the Bay of Fundy without using some kind of railway to transport his pontoons from the ship lift to the proposed shallow canal, and the conclusion was natural that, once on the railway, the ships might as well be hauled across to deep water on the other side, and thus avoid all question of water supply to the canal, etc. But, Mr. Ketchum says, it seems to him that the original plan could be applied to all the Canadian canals for the conveyance of vessels up to 20 ft. draft. Somewhat similar pontoons to those proposed, drawing 6 to 8 ft. of water, are used at Malta for vessels of 3,000 tons in cargo.

Mr. Ketchum then refers to the ship railway proposed in 1872 for crossing Honduras from the Atlantic to the Pacific Ocean, and to Capt. Ead's Tehuantepec ship railway. The first named project failed from lack of money; but the latter, which is described, is still alive.

The author next turns his attention to the Chignecto ship railway, which is 17 miles long and is designed to carry vessels of a total with cargo of 2,000 tons. The author first speaks of hydraulic lifts, and says that the lift in the Victoria docks has been used 30 years and has lifted 4,000 vessels with safety. It is 300 ft. long, 60 ft. wide and can lift 3,000 tons. In 1876, the Clarence Lifting Dock, at Malta, was the first to raise ships in cargo, and in August 1886, the "Glenasteg," 2,143 tons register, was lifted with 2,000 tons of cargo. The Bombay hydraulic ship lift raises vessels of 5,000 tons register.

Mr. Ketchum then refers to the ship cradle, with hydraulic cushions, patented by Mr. W. M. Smith, M. Inst. C. E., of Aberdeen, and quotes the opinions of Sir E. J. Reed and Prof. T. Claxton Fidler, M. Inst. C. E., on the subject of ship strains under transport. These opinions have both been widely published, in this journal and elsewhere, and it is sufficient to say that the conclusions arrived at is that there would be less strain in a ship carried on a properly constructed cradle than if that ship were lying in quiet water.

The second paper, that on the Chignecto Ship Railway, will be treated of in another issue in those parts not already given in this journal.

PLASTER BOARDS FOR FIREPROOF CONSTRUCTION.

In Mr. C. T. Purdy's article on "The Steel Skeleton Type of High Buildings," concluded last week, reference was made to the use of "Mackolite" as a substitute for tile in building partitions and in fireproofing columns and beams. The material sold under this name is a species of "plaster board." In our issues of April 12 and May 10, 1890, the process of manufacture of plaster boards, both in this country and Germany, was described. As now made in Chicago by the Mackolite Plaster Board Co. the process of manufacture is as follows:

The materials used are calcined gypsum, fibre, ground cork, reeds, and for especial purposes certain chemicals are added. The reeds and fibre are laid in open molds, and the gypsum, ground cork and chemicals are mixed with water in a large tub. Just as the gypsum begins to set, the mixture is poured over and around the reeds until the mold is full. The workman then uses his hands to work the reeds and make sure that they are all surrounded with the mixture and keep them from the surface as much as possible. As the mixture sets, it expands slightly, filling the mould completely. The top of the mould is struck off with a lath to make a rough surface. Ordinarily Mackolite is made in pieces 4 ft. long and 1 ft. wide; but it can be sawed or cut up into pieces of any dimensions with ordinary wood-working tools. It can be moulded into almost any shape desired. For partitions the material is moulded with hollows running the length of each piece, thus decreasing its weight. Mr. Purdy states that the use of Mackolite in place of tile reduces the weight fully 33⅓ per sq. ft. of partition. The manufacturers inform us that experiments have shown that heat is transmitted through Mackolite about one-fourth as rapidly as through the same thickness of burnt clay. This is what might be expected, as plaster-of-paris, the chief constituent of the material, is well known to be an excellent non-conductor, so good that it is strange that more attention has not been paid to it as a material for steam pipe and boiler covering.

As the materials of which Mackolite is made are very cheap, and the process of manufacture is simple, it is quite inexpensive. We are unable to give present prices at Chicago; but the American Plaster Co., which manufactures a similar material at Bergen Point, N. J., gave us prices some time ago as $30 to $35 per M. ft. B. M., f. o. b. at Bergen Point, with 2% discount for cash. The prices vary between the above limits, according to the thickness of the material, and whether it is waterproofed with asphalt paper or not.

THE HINSON-MILLER INTERCHANGEABLE CAR-COUPLER.

We illustrate herewith a car coupler designed for use on cars which have to run sometimes in passenger and sometimes in freight trains, and coupling automatically either with the Miller hook or with any coupler of the M. C. B. standard type. As seen by the drawings, it consists of two complete coupling heads, one of the Miller and one of the Hinson style, made on one casting with their axes at right angles to each other. This casting is hinged to a draw-bar shank similar to the M. C. B. standard, but heavier and stiffer. The hinge-pin on which the casting swings is 3 ins. diam.

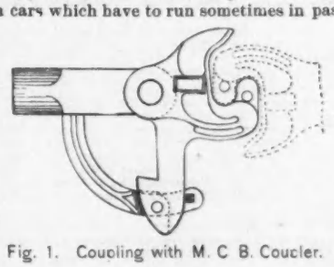


Fig. 1. Coupling with M. C. B. Coupler.

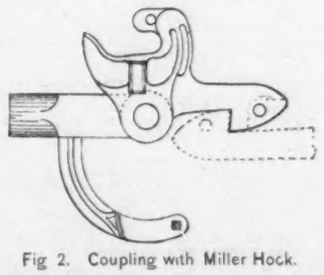


Fig 2. Coupling with Miller Hook.

The Hinson Miller Interchangeable Car Coupler.

Fig. 1 shows the Hinson coupling in use and the Miller coupling swung to the right, where it is supported by a projecting arm. A bolt through a slot in this arm holds the Hinson head firmly in place.

Fig. 2 shows the Miller coupling in use and the Hinson head swung to the right. In this position it bears against a strong elliptic spring secured to the car body. This spring tends to rotate the coupling head to the right and thus keeps the Miller coupling head pressed close up to its fellow on the next car.

The illustrations do not show any means for uncoupling the Miller coupler; but either the lever and chain ordinarily used with the Miller hook can be used, or a round rod and wheel like a brake staff is used, winding the chain against a dead stop to prevent breaking the chain after the parts are separated enough to uncouple. Briefly every part necessary for the correct working of each kind of coupler is retained in the combination device, and is so attached as to be durable and easily operated. The work of changing the combination from one coupler to another requires scarcely a minute. A considerable number of cars equipped with this coupler are now in service; among them are a number of private cars of several prominent railway officials. The device is made by the Hinson Car Coupling Co., Chicago, Ill.

WORKING NARROW GAGE RAILWAYS WITH LIGHT TRAFFIC IN NEW ZEALAND.

The following is an abstract of a paper by Mr. J. P. Maxwell, M. Inst. C. E., Commissioner of Railways in New Zealand, presented at the third meeting of the Australasian Association for the Advancement of Science, at Christchurch, New Zealand, in January, 1891. In our issue of Nov. 14, 1891, we gave a description and illustration of a New Zealand locomotive and saloon car, and further particulars in regard to these railways will be found in Engineering News March 30, 1889, and Oct. 31, 1891. The accompanying table is compiled from tables given in the paper.

The system of railway construction adopted by the Government of New Zealand was described at a meeting of the Institution of Civil Engineers in 1880*. With a population which has risen from 290,684 in 1874 to 626,000 in 1890, but still only averages 6 per sq. mile, New Zealand has now 1,726 miles of railway open to traffic, or at the rate of 1 mile to every 360 inhabitants, of which 627 miles are in the North Island, and 1,067 miles in the South, or Middle, Island.

The large mileage of railway in proportion to the population, the active competition of water-carriage at many points where the railways follow the line of cost, and the extension of other lines inland to mountainous and pastoral districts almost devoid of population, are mentioned as causes which explain the unfavorable appearance of many of the figures relating to the traffic receipts. On the remotest parts trains are run only once a week, and even on the busiest parts they run only during 16 hours a day, while all the heavy traffic, namely, timber, grain, coal, firewood, live stock, meat, etc., is toward the ports, where the population is concentrated, and a very moderate traffic in small lots of goods of a few hundredweight each forms the greater part of the return traffic. Hence the average non-paying load per wagon in New Zealand in proportion to the paying load is as 2 to 1, while on the great American railways it is stated to be as 2 to 1.75.

The average cost per engine mile for all locomotive expenses is 19 10 cts., including the Fell engine services on the Rimutaka incline, of 1 in 15 (6 6⅔), which has a center rail for about 2¼ miles. The Fell engines weigh 36 tons, and draw 70 tons up this grade at about 5 miles an hour. These engines ran 17,9.0 miles in one year, costing 92 cts. per engine mile. Iron rails of 40 lbs. per yd. were originally laid, but all renewals are made with 53-lb. steel rails.

The Napier line (97 miles) has no grade steeper than 2 2⅝. It penetrates into a fertile country producing timber, fire wood, wool, live stock, meat and dairy produce, and has neither water competition nor any non-paying branches. It presents an example of the results obtainable from a line fairly located in a good country, and, having cost $33,800 per mile, has earned 5% on its cost.

The Wanganui section (215 miles) has many steep grades and sharp curves. The maximum grade is 1 in 33 (3%). It traverses a district as fertile and productive as the Napier line, but, following the coast closely, is subjected to much water competition. The traffic is small and the distances carried are short, in consequence of which the expenses per ton are high.

The Auckland section (254 miles) has a large proportion of its length in unsettled country, with a little or no traffic on it. There is a mineral traffic in brown coals, and a light traffic in agricultural and pastoral products. The maximum grades are 1 in 40 (2.5%) and owing to its extending so far into unsettled districts the expenses per ton mile and per passenger-mile are higher than on the Napier section.

The Wellington line (91 miles) has a traffic similar to the Napier and Wanganui sections. It crosses a mountain range for a distance of about 18 miles, with grades of 1 in 33 and 1 in 40, and on the inland side against the chief traffic it has a grade of 1 in 15 on the Fell system, with curves of 330 ft. radius. This entails a great expense in locomotive power, and causes the general cost per ton mile to be very high.

* Minutes of Proceedings Inst. C. E., vol. lxiii. p. 50.

The Hurunui-Bluff section (1,069 miles), in the South Island, has maximum grades of 1 in 50 (2%), with curves of 495 ft. in the central part; but in the northern and southern portions the grades are flat. It has several brown coal and lignite mines, and the brown coals, costing from $1.80 to $2.04 at the pit mouth, are largely used for locomotive purposes. Grain, wool, live stock, timber, firewood, meat, and dairy produce form the chief traffic, but it has numerous short branches, which mostly penetrate sparsely populated pastoral districts, and generally furnish a very light traffic. It also passes by several seaports, so that the average distances over which the traffic is carried are very short, and, moreover, the maintenance charges, due to long and expensive bridges, are somewhat heavy, portions of the line being also subject to damage by floods,

The following tables show the chief results of the working of these railways:

Tables of Operating Statistics, New Zealand Government Railways.

Table No. 1.

Section.	Miles oper.	Expens's per ton mile. cts.	Expens's per pass. mile. cts.	Per centage of expenses to gross receipts.
Auckland	254	4.32	1.72	72.77
Napier	97	3.30	1.32	50.17
Wellington	91	4.84	1.94	65.02
Wanganui	215	6.16	2.46	71.98
Hurunui to Bluff	1,069	4.14	1.66	59.11
Total	1,726	4.28	1.72	62.88

Table No. 2.

Train miles	2,672,000
Total expenses	$3,081,0 0
Freight tonnage	1,645,000
Freight ton miles	46,359,000
Passenger journeys	5,500,000
Passenger miles	56,605,000
Cost of construction	$65,617,100
Net revenue	$1,940,000

TWO-CYLINDER COMPOUND TANK LOCOMOTIVE.

A compound locomotive of the Forney type, adapted for use on elevated railways, and having four driving wheels and a four-wheel trailing truck, has been built recently by the Rhode Island Locomotive Works, of Providence, R. I. The two-cylinder system of compounding has been adopted, the details of which are similar to those of the eight wheel compound engine built by the same works, and described in our issue of Dec. 12, 1891. The leading dimensions and particulars of the tank engine are as follows:

Cylinders, h. p	12½ × 20 ins.
Cylinders, l. p	16 × 20 "
Diam. of driving wheels	3 ft. 6 "
" truck wheels	2 " 2 "
" boder	3 " 8 "
Form of boiler	Belpaire.
Size of firebox	58 × 42⅛ ins.
Tubes, number	170
" length	6 ft. 3½ ins.
" diam., outside	1½ "
Driving axle journals	6 ins. diam × 6¾ ins. long.
Truck " "	3¼ " " × 6 " "
Wheel base, rigid and driving	5 ft. 0 in.
" " total	16 " 1 "
Weight on driving wheels	37,500 lbs.
" " truck	17,000 "
" total	54,500 "
Capacity of tank	600 U. S. galls.
Fuel	Anthracite coal.

The boiler is of homogeneous steel ⅝-in. thick, with extended arch, and a dome 20¼ ins. diameter. The tubes are of charcoal iron, No. 13 B. W. G., with copper ferrules on the firebox end. The firebox is of steel, ⅝ in. thick for side, back and crown sheets, and ⅞ in. thick for the tube sheet. The water space is 2½ ins. at side and back and 3 ins. at the front, with ⅝ in. staybolts 4¼ ins. pitch. The crown is supported by 1-in. radial stays. The pistons are of cast-iron, with cast-iron spring rings, and cold rolled steel piston rods. The guides are of hammered iron, casehardened, and the crossheads of cast steel. The connecting and coupling rods are of hammered iron forged solid, with straps and keys. The driving wheels are of cast iron, with Midvale steel tires 2 ins. thick and 5¼ ins. wide, all flanged. The axles are of hammered iron. The throttle valve is of the balanced poppet type, and the slide valves are operated by a shifting link motion. The feed water is supplied by two injectors. The truck is a center bearing, swing motion truck, with four double-plate chilled wheels and outside bearings. The driving box linings and connecting rod bearings are of Damascus bronze.

The behavior of railway employees toward passengers has been referred to in a circular recently issued to the staff of the North British Ry., Scotland, by Mr. Conacher, the new General Manager of the road, in which he says that the apparent unwillingness of the porters to be useful and obliging arises from a want of due appreciation of the importance of courtesies and civilities. He also reminds the agents and inspectors that they must take an increased interest in seeing that station premises are kept clean and in good order, that cars are kept clean inside and out, and that the porters are tidy in dress and active about their duties, aspecially in attention to passengers. The company has decided to introduce the premium system, giving prizes for the best kept stations. This road has a very important passenger traffic, and under the new management steps will be taken to improve the whole tone of the service. A revised book of rules for trainmen and other employees has recently been issued.

The longest electrical railway yet projected will shortly be built in Russia, says the "Zeitschrift fuer Transportwesen und Strassenbau." It will start from St. Petersburg and run northeasterly some 500 miles to Archangel on the White Sea. Power will be furnished from a number of intermediate stations along the line. A special commission was appointed to select the materials and the system to be adopted from among the Westinghouse, Thomson-Houston and others, which have proven efficient.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

CAMMAL & ENGLISH CENTER.—Work is in progress upon a 13-mile railway from Cammal to English Center, Pa. The road is being built by C. E. Titman, who will use it to transport lumber from his timber lands to the Pine Creek Ry.

PLYMOUTH & MIDDLESBORO.—Work will soon be under way on this railway from Plymouth to Middlesboro, Mass., 16 miles, the contracts for which were recently let to McCarthy Bros., of Franklin, Mass. Five miles of the work from Middlesboro east has been sublet, and the contracts for building the bridge over the Newmarket River and clearing the right of way have also been let. It is intended to have the line in operation by July 1.

ERIE & WYOMING VALLEY.—The local papers state that arrangements have been completed for beginning the construction of the proposed extension from Hoadley's to Honesdale, Pa., at an early date. The surveys for the line are nearly completed.

OHIO SOUTHERN.—Bonds have been voted to provide for an extension of this railway from Wellston to Point Pleasant, O.

HOOSAC TUNNEL & WILMINGTON.—The Hoosac Tunnel & Wilming on R. R. and the Deerfield River Co.'s R. R. have been consolidated under the name of the former company. The capital is $ 10,000, and the company will issue first mortgage bonds to the amount of $180,000. The consolidated company now owns the line from Hoosac Tunnel, Mass., to Wilmington, Vt., 25 miles, 13.4 miles of which were built this year. The officers elected are: Pres., D. H. Newton; V. P., Jas. Ramage; Treas., John C. Newton; Supt., Moses Newton; Aud., Jas. S. Newton.

WABASH.—In a recent interview an official of this company is reported as speaking as follows in regard to the Chicago extension of the road:

"The new road starts from Montpelier, Williams Co., O., ten miles east of the Indiana line and will pass through Steuben, LaGrange, Elkhart, St. Joseph, LaPorte, Porter and Lake counties. The towns along the line in Indiana are Eden, Hamilton, Hudson, South Milford and Wolcottville, Millersburg, New Paris, Benton, Lakeville, North Liberty, crossing the Lake Erie and Western road two miles and a half southeast of Stillwell, passing through the north edge of Kingsbury, and running on a straight line within a mile and a half of Westville, where it will make a curve of 2° to the northward and run direct through the latter place, and then continue in a direct line to Hammond, Ind. There will be no curve in the line greater than 2°, making it practically an air line road. Thirty miles of the road are being graded in Steuben and LaGrange counties, between Wolcottville and Hamilton, 400 teams being employed on the work, and 12 miles of heavy cuts and fills are being made in the vicinity of Lakeville. The right of way through Steuben, LaGrange, St. Joseph, a part of Elkhart, and Williams counties, O., has been secured and the deeds are recorded."

SANDUSKY & COLUMBUS SHORT LINE.—At the annual meeting of the directors of this company recently held the following officers were elected: Pres., H. C. Post, Sandusky, O.; V.-P. and Gen. Man., F. J. Ficard, Columbus, O.; Sec., Ed. H. Zurhorst, Sandusky; Treas., F. B. Taylor, Sandusky. At the same time a meeting of the directors of the Sandusky Construction Co. was held, and J. H. Stewart, of Sandusky, was elected President. Surveys and profiles are being made for the extension from Bellevue to Columbus, O., and it is expected to have matters in shape to begin construction in the spring and rapidly complete the line.

HUNTERS' RUN & SLATE BELT.—Tracklaying has been commenced on this railway from Pine Grove Furnace to slate quarries in Pennsylvania, 5.5 miles. Ch. Engr., W. E. Lehman, 711 Walnut St., Philadelphia, Pa.

BEECH CREEK.—The latest report in regard to this railway is that it will absorb the Altoona & Wapsononock R. R., under construction, and extend it to Coalport, Pa., where connection will be made with the Cresson Clearfield Co. & New York Short Route and the Pennsylvania & Northwestern R. R., and thence to Gazzam, Pa., on the Beech Creek. This would give the Beech Creek Co. a line into the coal fields of Cambria and Blair Counties, but would not, as stated, bring it any nearer Pittsburg, Pa., which is the objective point of the road.

MANISTEE & NORTHEASTERN.—Only 14.6 miles of this railway remain to be completed, and of this 7.2 miles have been graded. When completed it will run from Manistee to Traverse City, Mich.

PENNSYLVANIA.—This company will build a large amount of second track on its Pittsburg, Ft. Wayne & Chicago line during the present year.—Considerable work will probably be done during the coming season on extensions in Cambria and Indiana counties, Pa. Work is in progress upon a line between Kayler Station and Brubaker Junction, 20 miles, connecting the Ebensburg & Cresson R. R. and the Cambria & Clearfield R. R., and surveys are being made for a line from the Ebensburg & Cresson R. R. west via Carrolton, Pa., into Indiana Co. Surveys for several other lines are also reported in progress.—It is reported that extensive improvements will be made at Downington, Pa., including a large iron bridge and a new passenger station.

Projects and Surveys.

SKOWHEGAN & NORRIDGEWOCK.—The directors of this company will receive proposals until Feb. 1 for the complete construction, including buildings, of its proposed line from Skowhegan to Norridgewock, Me., 5.5 miles. Plans and specifications may be seen at the office of J. O. Smith, Clerk, 149 Water St., Skowhegan, Me.

COUDERSPORT & WELLSBORO.—Chartered in Pennsylvania to build a railway from Galeton to Ansonia, Pa., 13 miles. The directors are: L. H. Goodyear, A. W. Goodyear, N. M. Metcalf, H. I. Lewis, W. H. Sullivan, W. V. Henry, L. T. Johnson and Daniel Collins, Austin, Pa.

SYRACUSE & ONEIDA LAKE.—Walter F. Randall, Ch. Engr., 109 Sabine St., Syracuse, N. Y., writes us as follows:

"This railway is projected to run from Syracuse, N. Y., via Messina Springs, to South Bay, 12 miles. The surveys have been completed and good progress made in securing right of way. The curves will be 3° to 4°, and there will be two tangents, one seven miles long and one four miles long. The road is being built for the summer passenger traffic to Oneida Lake. The work will probably be done by the company, and the road opened for traffic some time in June, 892. Nelson L. Williams, Syracuse, N. Y., is President.

COLUMBUS & WESTERVILLE.—G. W. Meeker, Sec., Columbus, O., writes us as follows:

This road will be a little over 12 miles long and will connect the City of Columbus, O., with Westerville, a suburban town. The surveys have been completed and the right of way secured. The route is through a level country. There will be one bridge and three railway crossings. The principal business of the road will be the local freight and suburban passenger traffic. Moses H. Neil, Pres., Columbus, O.

MAINE.—A project is on foot to build a short railway from the Maine Central R. R. at Jay Bridge to water power on the Androscoggin River, two miles below Gilbertville, Me.

Southern.—Existing Roads.

MURFREESBORO.—This railway from Pendleton to Murfreesboro, N. C., 6.5 miles, has been opened for traffic.

ROANOKE, FINCASTLE & CLIFTON FORGE.—This company has been formed by a consolidation of the Roanoke, Fincastle & Clifton Forge R. R. Co., recently incorporated in Virginia and the Southern Boutetort Development Co., which is building a short railway from Fincastle to Cloverdale, Va. It proposes to build a railway from Roanoke to Clifton Forge, Va. The company is fully organized and contracts are reported let for construction.

ARCADIA, GULF COAST & LAKELAND.—It is stated that work has been begun from Braidentown to Sarasota, Fla., on this railway, and that within a short time a force of 1,200 men will be at work.

BISHOPVILLE.—The name of this South Carolina railway has been changed to the South & North Carolina R.R., and authority has been granted the company to extend its line.

GEORGIA, CAROLINA & NORTHERN.—This company is reported to have purchased the Augusta & Chattanooga R. R., project ed some years ago, to run from Augusta, Ga., to Chattanooga, Tenn., and will, it is stated, build the road as originally projected. The preliminary survey for the line was made some time ago and a small amount of grading done near Augusta.

ATLANTIC COAST LINE. Bids will be received for constructing an iron and steel train shed 300 ft. long and 50 wide at Goldsboro, N. C.

MONTGOMERY, TUSCALOOSA & MEMPHIS.—Grading has been entirely discontinued on this railway from Montgomery to Tuscaloosa, Ala., 107 miles. It is stated, however, that work will be resumed early in the spring, and that there will be no difficulty in obtaining the money necessary to complete the road.

SOUTH BOUND.—The rumor that this company would build an extension from Columbia, S. C., to Monroe, N. C., is gaining force. In addition to the marketing of new stock it is stated that the officials of the company are endeavoring to raise money in New York to provide for the work.

ALABAMA GRAND TRUNK.—The contract for building the first ten miles of this railway from Montgomery, Ala., toward the Tallapoosa River has been let to J. C. Adams, of Montgomery, Ala., the work to be finished by May 1.

NASHVILLE & KNOXVILLE.—The extension of this road has been completed from Cookville, Tenn., east to Aligood, Tenn., six miles, and the grading has been completed from Aligood to Standing Stone six miles further. From Standing Stone, the Nashville & Cumberland Gap R. R., has partly graded eight miles more east toward Knoxville, Tenn., and it is stated that this partly graded roadbed will be purchased and the work finished.

Projects and Surveys.

AUGUSTA, HIGHLAND & ALLEGHENY.—This company has secured the right of way from Staunton to Monterey, Va., 46 miles, for its proposed line. It is stated that the capital necessary to build the line has been secured. W. D. Rippetoe, Buffalo Gap, Va., is at the head of the enterprise.

WITHLACOOCHEE & GULF.—Chartered in Florida to build a railway from Lacoochee, Fla., to a point on the Florida Southern Ry., west of the Withlacoochee River, a distance of 50 miles. Among the incorporators are: Chas. G. Wilson, J. M. Baker, and J. C. Priest.

SOUTHWEST VIRGINIA CENTRAL.—This company, noted last week, proposes to build a railway from the Chesapeake & Ohio Ry., near Covington, Va., to the Norfolk & Western R. R., near Radford, Va. Among those interested are N. R. Stanger, Blacksburg, Va; Jas. T. W. Marshall, New Castle, Va., and J. L. Radford, Radford, Va.

MISSOURI, TENNESSEE & VIRGINIA.—It is stated that this company, which was chartered some time ago to build a railway from Bristol to Memphis, Tenn., has se-

cured the Tennessee Midland R. R., completed from Memphis, Tenn., east to Perryville, and will extend it

SOUTH CAROLINA.—The following railway companies have been chartered by the South Carolina State Legislature: Southeastern: Orangeburg; Wilmington, Norfolk & Charleston; Augusta, Aiken and Sumter; Gaffney City; Spartanburg Belt Electric; Sumter, Lake City & Conway; Catawba Falls; Florida, Georgia & Carolina; Charleston, Batesburg & Western; Hampton & Branchville; Charleston, Colleton & Berkeley; and the Walterboro, Summerville & Orlando.

PHOSPHATE RY. CO.—A correspondent writes us that this company has been organized to build and equip railways and has good men and plenty of capital at its back. W. H. Adams, of Ocala, Fla., and New York City, is President.

Northwest—Existing Roads.

DULUTH & IRON RANGE. An official of this route says that engineers will soon be put into the field to survey a 30 mile line west from Mesabi station, and that construction will begin in the spring.

CHICAGO, MILWAUKEE & ST. PAUL.—This company will double track 22 miles of its Chicago line. The work will consist of a double track from the suburb of Lake, south of Milwaukee, to Western Union June., a distance of 18 miles, and at the southern end of the line, from the station of Morton to that of Forest Glen, a distance of four miles. The construction work will begin early in the spring and will be pushed rapidly to completion.

CHICAGO & NORTHWESTERN.—It is stated that this company is making preparations to extend its line from Moville to Sioux City, Ia.

Projects and Surveys.

MARINETTE & WESTERN.—Geo. W. Henly, Sec., Marinette, Wis., writes us as follows:

"The preliminary surveys are now in progress for this projected railway, from Marinette, Wis., on Lake Michigan, west to a connection with the Wisconsin Central R. R. at Abbottsford, Wis., 160 miles. Two routes are under consideration one via Antigo and Merrill, and the other via Wausau. The route is through a good timber and farming country, and it is expected to have a large traffic in lumber, coal, grain and ores. There will be four large bridges. The company was chartered Nov. 16, 1891, and its officers are: Pres., Jesse Spaulding, Chicago, and Secy., Geo. W. Henly, Marinette." Treas., J. Vanclive.

FLORA & SAILOR SPRINGS.—The right of way has all been secured for this line from Flora to Sailor Springs, Ill. L. W. Barnes, Sailor Springs, Ill., is interested.

YANKTON, NORFOLK & SOUTHWESTERN.—The engineers of this company are completing the locating surveys for its line from Yankton, S. Dak., to Norfolk, Neb., 60 miles. About $122,000 of bonds has been voted in aid of the road by the towns along the route.

Southwest.—Existing Roads.

ST. LOUIS & HANNIBAL.—Work on the extension from Oakwood to Hannibal, Mo., is making rapid progress. Nothing except to scatter the ties has been done on the line from Perry to New London, Mo.

VELASCO TERMINAL.—A large shipment of rails and track material has arrived at Velasco, Tex., and tracklaying, which has been discontinued on account of the lack of material, will be resumed at once.

KANSAS CITY, WATKINS & GULF.—This company will, it is stated, build a branch from Jennings to Lake Arthur, La., 10 miles.

KANSAS CITY & INDEPENDENCE AIR LINE.—This company will begin tracklaying on its suburban line between Kansas City and Independence, Mo., at once. J. W. Heylman, Ch. Engr., Kansas City, Mo.

NEW ORLEANS & NORTHWESTERN.—It is stated by an official of this company that the money necessary to extend this line from Rayville, La., north toward Little Rock, Ark., has been secured.

HUTCHINSON & SOUTHERN.—Surveys are reported begun for an extension from the southern terminus of this railway, at the Kansas-Indian Territory Line, south to Denison, Tex.

LOUISIANA & NORTHWEST.—It is stated that this company will issue $450,000 of bonds to provide for an extension from Homer to Alexandria, La.

SAN ANTONIO & ARANSAS PASS.—The "Galveston News" gives the following extensions as contemplated by this company, any after its reorganization is completed: From San Antonio to Kennedy, 62 miles; Kennedy to Skidmore, 44 miles; Skidmore to Alice, 44 miles; Skidmore to Gregory, 34 miles; Gregory to Corpus Christi, 13 miles; Gregory to Rockport, 22 miles; Kennedy to Yoakum, 59 miles; Yoakum to Houston, 118 miles; Yoakum to Shiner 11 miles; Shiner to Lockhart, 55 miles; Shiner to Waco, 158 miles; San Antonio to Kerrville, 72 miles. Nearly all of these were projected several years ago before financial difficulties overtook the company, and a considerable work making surveys and securing right of way has been done.

AUSTIN & NORTHWESTERN.—About one-third of the extension from Fairland to Llano, Tex., 30 miles, has been located and the preliminary survey is nearly completed.

Rocky Mt. and Pacific.—Existing Roads.

DENVER, APEX & WESTERN.—The following details are abstracted from the report of a committee appointed by the Denver Real Estate Exchange to investigate this enterprise:

The Denver, Apex & Western R. R. Co., was chartered about one year ago to build a railwey from Denver to Georgetown, Colo., 49.5 miles, passing Golden and Idaho Springs. The line has been located from Denver to Georgetown, Colo. and preliminary surveys have been completed for an extension from Georgetown west to Salt Lake City, Utah, via Dillon, Leadville and Steamboat Springs, a distance of 659 miles. The line between Denver and Georgetown is quite favorable for mountain work, although the work will be heavy and expensive. The maximum grade is 2% and the maximum curve 12°. The company has done some grading in West Denver and has purchased the old roadbed of the Golden City South Platte R. R. in Golden, all of which has cost about $230,000. The line will be considerably shorter than the present lines between Denver and Salt Lake City, and will pass through good mineral sections of the states. The sale of bonds is well under way and by March 1 it is expected to have the line under construction.

RIO GRANDE WESTERN.—The possible extension of this railway to the Pacific Coast is agitating the various towns along the route. According to the latest news the line will be an extension of the Tintic branch and will pass through the Deep Creek mineral fields, Eureka and Austin, Nev., Candelera, Nev., and Bodie and Oakland, Cal., to San Francisco, Cal.

SOUTHERN PACIFIC.—Tracklaying began on the branch to Redlands, Cal., on Dec. 24, 1891. It is stated that about $250,000 will be expended on this company's lines in Oregon in relaying its Woodburn-Springfield Branch with 62-lb. steel rails.

NORTHERN PACIFIC.—About 600 men are now at work on the Chehalis-South Bend Branch and work will be continued during the winter.

GREAT NORTHERN.—The Pacific Extension of this road was completed to Kalispel, Mont., Jan. 2, 256 miles west of Pacific Junction, where it leaves the main line to Helena, Mont. There are 30 stations on the line. Tracklaying will stop at this point for the winter, but a large force of men will be kept at work during the cold weather on the yards and terminals.

Projects and Surveys.

ALBUQUERQUE & DURANGO.—The surveys for the proposed railway line from Durango, Colo., to Albuquerque, N. Mex., are completed, and a very favorable line has been obtained. The route is through a rich section of country. An endeavor will be made to interest eastern capital in the enterprise.

BELLINGHAM BAY & EASTERN.—This company, whose incorporation was noticed in our issue of last week, has let the contract for building its proposed line to A. L. McCoy & Co., Tacoma, Wash. The officers of the company are: Pres., Edward Eldridge; V. P. Ex-Gov. Haiber, Helena, Wash.; Secy., J. J. Donovan.

COLUMBIA RIVER & ASTORIA.—Griggs & Huestis, Tacoma, Wash., Contrs., have offered to build this railway from Goble to Astoria, Ore., for a bonus of $900,000; $400,000 in cash and the remainder in bonds.

PORT HARFORD & SAN JOAQUIN VALLEY.—A project is on foot to build a railway from Port Harford on the Pacific Coast, near San Luis Obispo, Cal., north and east into the San Joaquin Valley.

SEATTLE, BOISE & SALT LAKE.—The prospectus of this company, just issued, states that it was organized Dec. 9, 1890, to build a railway from Salt Lake City, Utah, northwest and north to some point on the Washington line in Idaho, and thence west to Seattle, Wash. The capital stock is $20,000,000. The construction of the road will be commenced at Payette, Idaho, for convenience in obtaining construction material.

Foreign.

MONTEREY & MEXICAN GULF.—Gen. Man. J. A. Robertson, states that this company will soon begin work on its extension toward the Pacific coast. It is intended to have the line completed to Mazatlan on the coast by 1894.

ELECTRIC RAILWAYS.

NEW YORK, N. Y.—The Harlem & Kingsbridge Ry. Co. has been organized to build a line 8 miles long from Mott Ave. station to the Yonkers line. Capital stock, $300,000. President, Chas. E. Runk. Secretary, George P. H. MacVay. Treasurer, Henry L. Phalon.

BROOKLYN, N. Y.—The aldermen's resolutions allowing the street railways to adopt the electric trolley system have been vetoed by the new mayor.

JERSEY CITY, N. J.—The Jersey City & Bergen Ry. has adopted the electric system and has let a contract to B. M. & J. F. Shanley for a line to Newark.

LANCASTER, PA.—A company has been granted a franchise to build a line to New Holland, 13 miles distant. President, C. A. Fondersworth. Capital stock, $360,000.

MACON, GA.—The Macon & Indian Springs Electric Ry. Co., will have two routes surveyed. Mr. T. J. Carling is President.

AURORA, ILL.—The Aurora & Chicago Interurban Ry. Co. has been incorporated to build a line to Chicago. Capital stock, $1,000,000. H. H. Evans, J. J. Luck and John Meredith, of Aurora; W. Van Northwick, of Batavia; W. J. Manning, of Chicago.

CRAWFORD, NEB.—A line to Fort Robinson is to be built by M. A. Manning, G. E. Ellis and Leroy Hall.

WINNIPEG, MAN.—A franchise for an electric railway has been awarded to James Ross, of Montreal, and Wm. McKenzie, of Toronto.

ELEVATED RAILWAYS.

HOBOKEN, N. J.—The North Hudson County Ry. Co. will extend its elevated road.

PHILADELPHIA, PA.—The Quaker City Elevated Ry. Co. has been granted a franchise for its line from Front and Market Sts. along Ridge Ave. to Lehigh Ave., and along Woodland Ave to the county line. President, Thomas Briggs.

CHICAGO, ILL.—The bonds of the Chicago & South Side Rapid Transit Co. have been taken up by Marshall Field, P. D. Armour and others, and work is to be carried to completion.

HIGHWAYS.

CONNECTICUT.—The Farmers' Convention has passed the following resolutions on the motion of Mr. J. H. Hale, of Glastonbury, and will lay them before the Assembly: "We favor such a change in the highway system of this state as shall place the control of all first class thoroughfares leading through several towns under the control of a county board of four persons, one of whom shall be a civil engineer and two others owners of unencumbered real estate in the county of a taxable nature of at least $3,000. Said board shall be appointed by the members of the General Assembly for each county for two years, any vacancy occurring during a recess of the General Assembly to be filled by the remaining members of the board until the county members of the General Assembly shall, at a regular or special meeting, appoint.

MISSOURI.—The Joplin Club, of Joplin, has appointed a committee to report on routes and cost of turnpikes to Galena and Webb City or Carterville. Capt. Wetherill, C. E., President of the club, is on the committee.

BRIDGES, TUNNELS AND CANALS.

MONTREAL, P. Q.—Bids will be received until Jan. 13, for the masonry and superstructure for a bridge over the Canadian Pacific Ry. on St. Catherine St.

POLK CO., MINN.—Bids will be received for constructing an iron bridge 220 ft. long over Red Lake River at Thief River Falls.

KANSAS CITY, MO.—Bids will be received until Jan. 13 for constructing an iron bridge over Cleveland Ave. Frank J. O'Flaherty, County Surveyor.

LITTLE ROCK, ARK.—The Southwestern Bridge Co., of Little Rock, Ark., has been incorporated with $100,000 capital stock, to manufacture and sell all kinds of iron, wooden and combination bridges. The incorporators are W. B. Woody, Rockdale, Tex.; J. O. Hill, Navasota, Tex., and T. M. Freeman, Little Rock, Ark.

SEALED bids will be received until Jan. 19, for work connected with sections D, 12 and 13 of the Soulanger Canal. T. Trudeau, Dept. Rys. & Canals, Ottawa, Ont.

NEW ORLEANS.—A resolution has been introduced in and passed the New Orleans City Council directing that plans and specifications be prepared for a canal on Claiborne St.

WATER-WORKS.

New England.

BELLOWS FALLS, VT.—J. H. Webb has offered to increase the supply by piping water from Webb Brook into the pond. Price, 6¾ cts. per 1,000 galls.

BENNINGTON, VT.—It is reported that the company will double the capacity of its storage reservoirs.

ATTLEBOROUGH, MASS.—The Committee on Water Supply has recommended that a new supply be obtained from the valley of the Seven Mile River. The plan includes a supply well, pumping station and 17,870 ft., or about 800 tons, of pipe, weighing 90 lbs. per ft. Estimated cost, $17,856. G. A. Dean, C. E. Bliss and others compose the committee.

Middle.

ALBANY, N. Y.—The Special Water Commission has reported that in its opinion the Normanskill would furnish an ample supply of good quality for the use of the city. Accompanying the report is one from Engr. I. M. de Varona, Brooklyn, N. Y., which contains results of daily gagings of the stream for several months.

ARENA, N. Y.—The Arena Water Co. has been organized to build works and has elected C. C. Blodgett Prest., and D. A. Fletcher, Secy.

GLENS FALLS, N. Y.—Engr. Geo. P. Slade has just completed surveys for the citizens' committee for a dam across Condon Brook to impound a gravity supply. A dam 512 ft. long with an average height of 16 ft. is proposed.

NEWBURG, N. Y.—The people have voted $135,550 for improvements.

SYRACUSE, N. Y.—Bids addressed to Cy. Treas. B. W. Roscoe, are wanted until Jan 18 for $200,000 3½, 20 year, bonds.

HARRISBURG, PA.—A popular election will probably be held to vote on issuing bonds for a filtering plant.

HYNDMAN, PA.—The people have voted a tax to provide for a water supply.

McKEEPSPORT, PA.—The Water Commissioners have recommended improvements at an estimated cost of $125,000, including new boilers, two pumps, force main, reservoir, distributing mains and hydrants.

MONTROSE, PA.—A supply from artesian wells in Fair Ground Hill is talked of.

PITTSBURG, PA.—A supply for Squirrel Hill has been recommended, including a tank.

Southern.

AIKEN, S. C.—We are informed that works are soon to be built by the city and contractors are invited to correspond with Robt. A. Chafee, Mayor.

ATLANTA, GA.—The Commissioners wish bids until Jan. 20 for 15 horizontal tubular boilers, each 5 × 18 ft., with dome 33 ins. in diameter and 42 ins. high. G. W. Terry, Jr., Secy. Bids will soon be asked for constructing the new reservoir and a railway about 1½ miles in length.

AVONDALE, ALA.—M. W. Steele, Mayor, has written to the Chattanooga "Tradesman," stating that the Birmingham Water Wks. Co. has just made a survey for an extension of its mains to supply Avondale and Woodstown.

LA FAYETTE, LA.—Address Numa Schayot regarding proposed city works.

CHATTANOOGA, TENN.—The City Water Co. has applied for an amendment to its charter allowing it to increase its capital stock to $1,500,000. Supt., Nesbit Wingfield.

HARRIMAN, TENN.—It is reported that the city thinks of building works, and that Cy. Clk. W. H. Parsons should be addressed for information. As reported two weeks ago the Harriman Water Co. has just been incorporated.

North Central.

NEW CUMBERLAND, O.—Works are talked of.

SELMA, IND.—It is reported that Frank Whitney will build works here in the spring.

SAGINAW, MICH.—Engr. J. D. Cook, Toledo, O., has reported on an improved supply from Tittabawassee River for the western district. A 30-in. brick conduit to the pumps, a new 6,000,000-gall. pump, new boilers and 8,500 ft. of 20 in. force main are recommended. Estimated cost, $96,500.

BEARDSTOWN, ILL.—The Beardstown Water Co. has been incorporated by Geo. W. Sturtevant, Jr., Chas. P. Sturtevant and T. K. Condit; capital stock, $28,000.

PANA, ILL.—An artesian well is being sunk for a water supply.

KAUKAUNA, N. Y.—It is reported that Hyde & Jackson, New York City, have applied for a franchise to build works estimated to cost $100,000, and having 70 hydrants.

Northwestern.

DUBUQUE, IA.—The "Telegraph" states that Mayor Saunders will recommend that the council petition for power to build city works. The present supply is furnished by a company.

GLENWOOD, IA.—Seth Dean, County Surveyor, informs us that bonds to the amount of $10,000 have been voted to begin the construction of works. No contracts have been let.

NEBRASKA CITY, NEB.—It is reported that the company's works will soon be sold under foreclosure. D. P. Rolfe is Receiver.

Southwestern.

KANSAS CITY, MO.—Bids for the $2,000,000 of city water works bonds will be received until Feb. 5 instead of Jan. 5.

ST. LOUIS, MO.—Bids will be received until Jan. 26 for furnishing and delivering about 1,300 tons of 6, 12, 20 and 30-in. coated cast-iron pipe, 50 tons special castings, 50 6-in., four 12-in., six 20 in. and two 30 in. stop valves and 25 hydrants; also for making excavations for, hauling and laying about 11,000 ft. of 20 in., 1,300 ft. of 30-in., 200 ft. of 6-in. pipe, setting 10 hydrants, furnishing 1,000 lbs. wrought iron straps and bands, and taking up about 3,000 ft. of 6-in. pipe. Geo. Burnet, Prest., E. S. Foster, Secy.. Bd. Pub. Wks.

BATESVILLE, ARK.—It is reported that the American Construction Co. has obtained a franchise to build electric lighting and water-works plants

COMANCHE, TEX.—The city has voted to issue $15,000 of street improvement and water-works bonds.

HENRIETTA, TEX.—Negotiations for works are reported as under way.

ORANGE, TEX.—Works are still projected.

Pacific.

TACOMA, WASH.—Wm. C. Pyfer has applied for a franchise to supply the city south of the sixth addition.

LOS ANGELES, CAL.—Cy. Engr. J. H. Dockweiler has submitted a report on water-works to be owned by the city. He recommends a gravity supply from the Los Angeles River, with pumping for higher levels. He proposes to divide the city into three districts, which could be supplied for a total cost of $2,952,500, not including $225,000 for filters and $100,000 for street repairs. For the present a supply could be introduced at a less cost. Three or more companies now supply the city.

Canada.

VANCOUVER, B. C.—Cy Clk. T. F. McGuigan will receive bids until Feb. 1 for 1,850 tons of cast iron pipe and castings, 80 tons pig lead and pipe, 100 hydrants and 200 valves. T. H. Tracey is City Engineer.

ARTESIAN WELLS.

NORFOLK, VA.—Bids will be received until Jan. 19 by the Bureau of Yards and Docks, Navy Department, Washington, D. C., for driving double pipe wells at the navy yard here. N. H. Farquhar is Chief of Bureau.

AURORA, ILL.—The Council has voted $20,000 of bonds for a second artesian well.

SEWERS.

NASHUA, N. H.—Mayor Beasom says a more extensive sewerage system will soon be necessary, and he recommends that plans be commenced this year.

NEWTON, MASS.—The sewerage committee recommends the extension of the system during this year to the districts of West Newton and Newton Centre.

NORTHAMPTON, MASS.—Mayor O'Donnell devotes much attention in his inaugural address to the extension of the sewerage system to the suburb of Florence, 2½ miles. He advises a separate system, for sewage only, to cost about $62,000, and that it be built at once.

SHELBURNE, MASS.—The selectmen have had the streets surveyed, and the matter of a sewerage system will be brought up at the next town meeting.

BROOKLYN, N. Y.—Proposals will be received until Jan. 15 for the construction of 3 sewers in District No. 29. Address John P. Adams, Comr. City Wks.

HOBOKEN, N. J.—The commissioners to repair the Ravine road sewer have prepared a plan, which must be first accepted by the Jersey City authorities before work begins. The estimated cost is $70,000.

CHAMBERSBURGH, PA.—It is expected that $100 000 will be spent on a complete system.

NEW BERNE, N. C.—Robert M. Cole and two others of New York, and Geo. F. Wyman, of New Berne, are the incorporators of the New Berne Sewerage Co., capital $150,000, formed to maintain and operate a system of sewerage.

GREENVILLE, S. C.—An election will soon be held to vote on issuing $75,000 of bonds for a sewerage system.

COVINGTON, KY.—A bill will soon be introduced into the legislature authorizing the city to spend $100,000 on the construction of a trunk sewer through Willows Run Bottoms.

COLUMBUS, O.—The City Engineer has been directed to report an estimate and plan for the construction of all the sewers in Sub-sewer District O of District No. 2.

MERIDIAN, MISS.—The Mayor and Aldermen wish to correspond with parties relative to the construction of a sewerage system *now*, with the proviso of buying the system or granting a franchise *after* an election shall be held to vote upon bonding the city to pay for such system. We have been asked by the City Engineer to name possible candidates for such a contract, and being unable to do so, publish it here for the benefit of whom it may concern. Address N. M. Brandon, City Engineer.

OWATONNA, MINN.—The city has received the plans and specifications for a system of sewerage, and has them under consideration.

JANESVILLE, WIS.—C. W. Loweth, of St. Paul, is preparing plans for a complete sewerage system.

KANSAS CITY, KAN.—The City Engineer has prepared plans for an extension of the Ohio Ave. sewer. It will be built of brick and riprapped with rock, and is estimated to cost $18,000.

SANTA FE, N. M.—P. O. Gaynor, of Pueblo, Col., has been engaged to prepare plans and estimates for a complete system.

WINNIPEG, MAN.—The Board of Works has awarded contracts for sewers on three streets to Dobson & Jackson, and on one street to W. F. Lee & Co.

STREETS.

BROOKLYN, N. Y.—The Commissioner of City Works will receive bids until Jan. 13 for grading and paving on four streets cobblestone to be used on two and Belgian blocks on two

BUFFALO, N. Y.—The contract for paving Davis Ave. with Barber's Trinidad asphalt has been awarded to the German Rock Asphalt Co., at $24,199. The Barber Asphalt Co. bid $24,312. For paving Crescent Ave. with "Genuine Trinidad Asphalt" the contract was awarded the German Rock Asphalt Co. at $20,695. The Barber Asphalt Co. was given the contract for repaving Canal St. with Medina block stone, with a filling of German Rock asphalt, at $8,568.

WASHINGTON, D. C.—The District Commissioners will receive bids until Jan. 15 for graveling and other work on Connecticut Ave. extended and connecting streets.

GREENVILLE, S. C.—The city will soon spend $15,000 for street paving.

DE LAND, FLA.—The city will soon contract for about 2 miles of streets to be paved with clay and shells.

CINCINNATI, O.—The Board of Administration will receive bids until Jan. 30 for improvements on two streets, work to include grading, curbing, guttering and paving one roadway with granite blocks, the other with macadam.

COLUMBUS, O.—Bids have been ordered for the improvement of one street, and the City Engineer has been instructed to prepare plans and estimates for work on several others.

MASSILLON, O.—The City Engineer estimates that the contemplated paving of S. Erie St. will cost $19,505.

NEWARK, O.—The City Council asks for proposals until Feb. 1 for either labor or material, or both, for paving East Main St. with brick.

SOUTH BEND, IND.—The Council has authorized the issuing of $15,000 of bonds for paving improvements. The contract for grading on several streets has been awarded to Siders Bros.

WEST DULUTH, MINN.—The City Engineer has submitted plans and estimates, aggregating $183,250, for work to be done this year. Bids will soon be asked.

WINONA, MINN.—The City Council is having plans and specifications prepared for a mile of brick pavements, for which bids will soon be asked.

SANTA BARBARA, CAL.—The city voted Dec. 26 to issue the proposed $76,000 of bonds for the construction of a boulevard on the beach, to be paved with asphalt.

ELECTRICAL.

LANSINGSURGH, N. Y.—The village trustees are investigating the cost of electric lighting. It is said 109 lamps are the estimate, and it is thought the cost would be about $12,000 annually.

LONG ISLAND CITY, N. Y.—The City Council has awarded the contract for electric lighting for 5 years to the Long Island City Electric Light Co., at $160 per light per year.

NEW YORK, N. Y.—The city's contracts for electric lights for the current year have been renewed at the prices of 1891.

PENARGYL, PA.—S. Barton is interested in the organization of a new company, to be incorporated for supplying light, heat and power.

VICKSBURG, MISS.—The City Council has awarded a contract to the Hill City Electric Light Co. for 60 arc lights, 2,000-c.p., at $9.50 each per month, for 3 years.

CRAWFORDVILLE, IND.—The City Council has decided to borrow $20,000 with which to enlarge the capacity of its electric light paint. This has been made necessary by the city furnishing incandescent lights to stores.

NEGAUNEE, MICH.—The city has contracted for 30 lights to burn all night at $10 each per month.

OSKALOOSA, IA.—The city clerk will receive bids until Feb. 1 for lighting the city for 5 years. Bids will be received separately for 85 arc lights, 225 incandescent lights and 225 gas lights.

NEW COMPANIES.—North River Electric Light & Power Co., New York City; Henry D. Fuller, Bayonne, N. J., Robert Maillard, Brooklyn, N. Y., and Schuyler C. Strock, New York; $200,000.—The Ozone Park Electric Light & Power Co., Jamaica, N. Y.; John N. Williamson, Ozone Park, L. I., Henry C. Rath, Flushing, L. I., and D. B. Emmons, Brooklyn; $2,000.—Dolgeville Electric Light & Power Co., Dolgeville, N. Y.; Alfred Dolge, Dolgeville, Edmund R. Wauckel, New York, and Otto Voigt, Dolgeville; $25 000.—Cortland & Homer Electric Co., Cortland and Homer, N. Y.; C. B. Hitchcock, Tallapoosa, Ga., F. R. Hitchcock and H. Wells, both of Cortland, N. Y.; $50,000.—Edison Electric Illuminating Co. of Coney Island; Manuel A. Plaisanter, Josephine V. Cook and Eugene De Fere, all of Brooklyn; $50,000.

CONTRACT PRICES.

STREET WORK.—San Francisco, Cal.—The Street Committee has awarded the following contracts: Grading Vermont St., C. A. Warren, 29 cts. per cu. yd.; paving Quincy Place with bituminous rock, San Francisco Paving Co., 90 cts. per sq. ft.; paving Clementine St. with basalt, Robert Boyd, 18½ cts. per sq. ft.

WELL.—Racine, Wis.—The contract for boring an artesian well at the Racine County Asylum has been awarded to the O'Connor Artesian Well Co., of Fond du Lac. Its bid was $1.57 per ft. for the first 1,000 feet.

DREDGING.—Boston, Mass.—The following proposals for dredging about 200,000 cu. yds. from a section of the reserved channel and filling about 233 cu. yds. upon a portion of the South Boston flats were received Dec. 31 by the Harbor and Land Commissioners. The channel is to have a uniform depth of 12 ft. at mean low water, a total width of 280 ft. (including its present width of 110 ft.), with side slopes of 2 to 1. The filling is to be to 13 ft. above mean low water, and the contractor will receive material dredged from the Upper Middle Bar. Geo. W. Catt (agent of San Francisco Bridge Co.), 20 cts. per cu. yd., measured in the fill; Massachusetts Dredging Co., 23 cts.; New England Dredging Co., 29 cts.; Eastern Dredging Co., 30 cts.; Boynton Bros., 37 cts.

MISCELLANEOUS.

GAS.—New York, N. Y.—The Gas Commission on Jan. 4 made the following awards: Equitable Gas Light Co., for lamps along its mains (price limited by law), $12 per lamp per year; Standard Gas Light Co., similar conditions, $13.04½; New York Mutual Gas Light Co., $17.50; Consolidated Gas Light Co., $17.50; Central Gas Light Co., which has a monopoly in ward 23, $27; Northern Gas Light Co., monopoly in ward 24, $28; Yonkers Gas Light Co., $28.

GARBAGE.—Brooklyn, N. Y.—Bids for the removal of garbage for 5 years were opened Jan. 4. There were 9 bids, ranging from $800,000 for the 5 years to $757,200, that of Bartley French being lowest.

BRICKS.—Washington, D. C.—Proposals for 800,000 vitrified bricks will be received by the District Commissioners until Jan. 18.

WHARF.—San Francisco, Cal.—Proposals will be received until Jan. 28 for furnishing all material and labor and constructing a pile wharf at Yerba Buena Island, San Francisco harbor. For information address Lt.-Col. W. H. H. Benyaurd, U. S. Engineer Office.

DITCH.—Vincennes, Ind.—The contract for digging the Grand Cooley ditch has been awarded to L. T. Harding & Sons, of La Porte, Ind., at $16,000. The main ditch is 10 miles long and there are 5 miles of laterals.

JAIL.—Thomaston, Ga.—Bids are asked until Feb. 2 for the erection and completion of a sheriff's residence and jail for Upson Co., Ga. Address M. H. Sandwich, Clerk of the County Commissioners.

BONDS.—Fort Worth, Tex.—The city has issued $170,000 of general improvement bonds.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Baldwin Locomotive Works, of Philadelphia, Pa., have an order for 40 engines for the Baltimore & Ohio, and 20 four-cylinder compound engines, 28 tons each, for the Chicago & South Side Rapid Transit Co. The Pittsburg Locomotive Works have an order for 20 engines for the Manhattan Elevated road, New York. The Baltimore & Ohio is building 8 express engines with cylinders 20 × 24 ins., and driving wheels 78½ ins. in diameter, 8 ten-wheel engines with driving wheels 74 ins. diameter for passenger service on the mountain division, and 25 freight and switch engines. The Lehigh Valley has ordered a number of engines for its new line.

CARS.—The Missouri Car & Foundry Co., of St. Louis, Mo., is building 1 000 freight cars for the Chicago, Burlington & Quincy. The Michigan Car Co., of Detroit, Mich., has a contract for 500 freight cars for the Pennsylvania. The St. Charles Car Co., of St. Charles, Mo., has built 150 coal cars of 60,000 lbs. capacity for the Texas Pacific. The J. G. Brill Co., Philadelphia, Pa., has built 8 eight-wheel electric cars for the Jamestown, N. Y., St. Ry. Co. The Chicago & South Side Rapid Transit Co. will place orders for passenger cars, and has specified that they shall be fitted for lighting by the Pintsch gas system. The Pullman Palace Car Co. has orders on hand for 425 cars. The Madison Railway Equipment Co., of Madison, Ill., has been organized by C. D. McClure, A. B. Ewing and T. C. Salvater; $100,000. The Souder Railway Freight Car Co., of Newport, Ky., has been incorporated by J. J. May, E. E. Hughes and P. Engelskirger, $2,000,000, to operate the patents of J. J. Souder, of Washington, D. C. The New York Central & Hudson River is building 8 mail cars at the West Albany shops. They are 60 ft. long, fitted with all modern improvements, and will be lighted by the Pintsch compressed gas system.

CAR HEATING.—The Consolidated Car Heating Co. states that it had a prosperous business for the last four months of 1891. It supplied railways with 13,459 steam couplers, 459 complete car equipments and 162 locomotive equipments. The Old Colony has had 90 equipments, the Boston & Maine 175, the Canadian Pacific 45, the Concord & Montreal 64, and the Wagner Palace Car Co. an average of 10 equipments a month. The company also reports having on Jan. 1 orders to be filled for 130 complete car equipments. The Wagner Palace Car Co has adopted the improved Commingler (McElroy) system as well as the Sewall coupler.

SIGNAL.—The Chase Automatic Electric Railway Crossing Signal Co. has been organized at Boston, Mass. The signal is the invention of E. M. Chase, and manufactured by F. H. Holton & Co., of Cambridgeport. The apparatus is operated by the locomotive or car pressing a lever pivoted alongside the rail; this lever makes electrical connection which operates a clock mechanism, to which the signal gong is attached. As the train passes the danger point another lever stops the gong and rewinds the mechanism ready for another train.

WESTINGHOUSE CHURCH, KEEN & Co. have put in ten 250 HP. Westinghouse compound engines to run the dynamos of the Minneapolis (Minn.) Street Ry. Co.

THE EQUITABLE ENGINEERING & CONSTRUCTION CO., of Philadelphia, Pa., went into liquidation on Jan. 1. The company announced that business for the past year had been profitable, but the active members of the concern wished to get out of the business. Mr. S. Ashton Hand has accepted a position as superintendent of the Detroit Electrical Works, Detroit, Mich., and Mr. W. A. Stadelman wishes to devote his time to his interests in the Bristol Belt Line Ry. and the Bristol & East Tennessee R. R., Bristol, Tenn. The company retires from business with every debt paid, and a good balance to be distributed as a dividend to the stockholders.

NEW COMPANIES.—Standard Engineering Co., of East St. Louis, Ill.; $250,000; P. Ross, Geo. W. Candle and H. C. Wichers. W. W. Wheeler Co., of Chicago, Ill.; asphalt paving; Hugh Mac Diarland, A. F. Telling and W. W. Wheeler. Chicago Foundation Pavement Co., of Chicago, Ill.; E. Ulrich, J. A. Smith and W. G. Goodrich; $100,000. Chicago Power Supply & Smoke Abating Co., of Chicago, Ill., to supply compressed air; $10,000,000; J. P. Bacon, Chester M. Dawes and John H. Hume.

CURRENT PRICE LIST.

RAILS.—New York: $30 to $30.50; old rails, $21 to $21.25 for iron and $14 to $15 for steel; girder rails, $40. Pittsburg: $30; old rails, $22.50 for iron and $16.75 to $17.50 for steel. Chicago: $31; old rails, $21.75 to $22.25 for iron and $13.50 to $15 for steel.

TRACK MATERIALS.—New York; steel angle bars, 1.7 to 1.9 cts.; spikes, 2.15 to 2.25 cts.; track bolts, 2.8 to 3 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.7 to 1.8 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.65 cts. with square and 2.75 cts. with hexagon nuts. Chicago: splice bars, 1.8 cts. for iron and steel; spikes, 2.2 to 2.25 cts.; track bolts, 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½% on black and galvanized butt-welded; 67½ and 55% on black and galvanized lap-welded. Casing, 55%.

FOUNDRY PIG IRON.—New York: $14.50 to $18. Pittsburg: $14 to $16. Chicago: $14.25 to $16.

LEAD.—New York: 4.25 to 4.3 cts. Chicago: 4 to 4.05 cts. St. Louis: 3.9 to 4 cts.

STRUCTURAL MATERIAL.—New York: beams, 3.1 cts. channels, 3.1 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2 75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.9 to 2.1 cts. for tank, 2.15 to 2.3 cts. for shell. 2.4 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles 1.9 to 2 cts.; tees, 2.3 to 2.4 cts.; universal iron mill plates, 1.9 to 2 cts.; sheared steel bridge plates, 2 to 2.1 cts.; refined bars, 1.75 to 1.8 cts.; steel plates, 1.85 to 2.5 cts. for tank, 2 to 2.1 cts. for shell, 2.25 to 2.5 cts. for flange, 3.5 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.05 to 2.15 cts.; tees, 2.4 cts.; universal plates, 2.12½ cts.; sheared steel plates, 2.2 to 2.25 cts.; steel plates, 2.4 to 2.6 cts. for tank, 2.75 to 3.5 cts. for shell, 3 to 3.25 cts. for flange.