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THE LABOR STRIKE in Chicago and the combination of the building contractors to resist the demands of the labor organizations has been followed by the locking out of the employees of 59 contractors' supply firms, mainly those dealing in brick, cement, stone and sand. These firms claim that as the building business is practically stopped they cannot afford to continue work. About 10,000 men are thus added to the number on strike and locked out, bringing the total up to about 45,000. A strike of machinists has been started, and has affected several of the large machinery manufacturing firms.

NEW YORK UNDERGROUND RAPID TRANSIT RAILway matters have progressed favorably during the past week. The committee of the Municipal Assembly who are arranging the programme for the celebration of the formal commencement of the work have settled upon March 24 as the date. The Rapid Transit Commission has introduced a bill into the New York State Legislature which will amend the present rapid transit act so as to establish beyond question the Commission's authority to plan and build extensions of the tunnel to Brooklyn and the other outlying boroughs of the city. In view of the Commission's decision, which was announced in our last issue, to make surveys for an extension to Brooklyn, the Long Island R. R. Co. has withdrawn its application for a franchise to extend its road by tunnel to Manhattan, as described in Engineering News of May 18, 1899. The reasons given by the railway company for its action is that a private corporation cannot compete with a tunnel railway built at the public expense.

CENTRAL CONTROL OF PUBLIC WATER SUPPLIES in the interests of purity and impartial distribution between different municipalities occupied the whole time of the half-yearly meeting of the British Association of Water-Works Engineers at London on Feb. 17. The discussion was opened by Mr. C. E. Jones, of Leyton, who read a paper in which he proposed that the whole matter be entrusted to a national water-works board, consisting of representatives of the law, geology, hydraulic engineering, chemistry and meteorology, being at the same time practical and proficient men of sound judgment and common sense.

The following speakers showed little unanimity of opinion except on the one point that something should be done to conserve the sources of water supply and to ensure their proper distribution between the communities which are or soon will be dependent upon them for life and health. A full report of the discussion is given in the London "Contract Journal" for Feb. 21 and 28, occupying eight closely printed pages. The secretary of the association is Mr. W. G. Peirce, Water-Works Engineer, Richmond (Surrey), England.

THE STRICKLER TUNNEL under Pike's Peak, for the water supply of Colorado Springs, Colo., was finished on Dec. 3, 1899, five days ahead of the contract time as extended. The firm of Wilson & Jackson and George W. Jackson still retain possession of the tunnel, pending final payments and other obligations assumed by the city in payment for the work. In September, 1899, the city council granted to George W. Jackson a franchise for the right to use the water from the city water system to develop power. This franchise was given as compensation for finishing the tunnel, in place of cash payments. At the same time that this franchise was granted, the time for completing the tunnel was extended to Dec. 8, 1899. For the above particulars we are indebted to Mr. George W. Jackson, of the Geo. W. Jackson Construction Co., of 70 La Salle St., Chicago, which company built the tunnel. A review of the history and progress of the enterprise was given in our issue of March 30, 1899, and the tunnel and water supply system were described and illustrated in our issue of Aug. 27, 1896.

WORK ON THE SEWERAGE SYSTEM OF HONOLulu, H. I., is to be prosecuted vigorously, judging from the recent action of the Council of State, which authorized the expenditure of $345,253 on Feb. 19. Part of this sum will go to satisfy claims already contracted and the balance for extensions, especially with a view to check or prevent future ravages of the plague. The sewerage system was designed by Mr. Rudolph Hering, M. Am. Soc. C. E., of this city.

BIDS FOR THE RIGHT TO USE PATENTED GARbage furnaces are wanted by the city of Milwaukee, Wis., until March 24. The furnaces must have a capacity of 1.0 tons in 24 hours. Bids must be accompanied by plans and specifications, statements of the kind of fuel and amount per ton of garbage required, the number and character of operators, a list of places where the system is in use and a bond in the penal sum of $25,000. Mr. Chas. J. Poetsch is city engineer.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred at Allegheny, Pa., on the Pittsburg, Fort Wayne & Chicago R. R., on March 7. One of the spans of a bridge over Robinson St. went down under a heavy locomotive, and two men were killed and one seriously injured. The engine was hauling a heavy freight train and was moving slowly at the time of the accident. The span was 60 ft. long and consisted of heavy steel girders.

SOO SHIP CANAL IMPROVEMENTS are demanded by the Lake vessel-owners, to avert, at any cost, a repetition of the accident to the steamer "Houghton" of last year, whereby lake commerce was blocked for a time at the most profitable season of the year. The "Houghton" grounded across the channel, and blocked traffic. The shipowners suggest that the channel be doubled in width at the Neebish; or the west channel should be deepened and separate paths made for ships. Either improvement would require the expenditure of about $5,000,000, including the improvement of the old ship canal at the Soo to 1,100 ft. in length; all this work could be done in four years. The majority seem to favor the two channel scheme.

A COAL FAMINE IN GERMANY, says Consul-General Mason, of Berlin, is shutting down many manufactories. The Prussian State railways have contracted for a large quantity of coal at an advance of 42%. One cause of the trouble is that England, which last year supplied Germany with 5,000,000 tons of coal, can only spare about 2,000,000 tons this year. Russia is in a similar plight, and has removed the tariff of $2.80 per ton on coal and increased the price of naphtha 400%. Silesian coal, in small lots, sells for $5 per ton in Berlin, and bituminous lump coal brings $4.04 to $4.28 per ton at Hamburg. The Consul-General says that now is the golden opportunity for American coal producers to establish a permanent trade in coal; and he scolds American mine owners for only exporting 5,000,000 tons last year, against 36,000,000 tons for England. The German supply of pig-iron is also growing short, says Mr. Mason, and old iron now commands $19.27 per ton, and old rails $25.46 to $26.65 per ton. The German pig-iron output for 1900 will inevitably be restricted as a consequence of the coal famine.

THE STEEL RAIL PRODUCT is reported upon by the American Iron & Steel Association as follows: The total production of Bessemer steel ingots, in 1899, was 7,586,354 gross tons, against 6,609,017 tons in 1898; of the 1899 output Pennsylvania made 3,968,779 tons; Ohio, 1,679,237 tons, and Illinois, 1,211,295 tons. The production of Bessemer steel rails, in 1899, was 2,240,767 gross tons; the next largest production was 2,044,819 tons in 1887. These figures do not include re-rolled rails. Pennsylvania alone made 1,224,807 tons of steel rails, against 1,015,960 tons for all other States. The rail industry is extremely profitable just now, says the Association. Standard steel rails, of 50 lbs. or more to the yard, sell for $35 per ton at the mill; and this leaves "a clean profit of $15 per ton," and with well equipped mills this profit is probably larger.

BEET SUGAR PRODUCTION for the fiscal year 1899-1900, is estimated by the Treasury Bureau of Statistics, at 5,480,000 tons, as against 2,862,000 tons of cane sugar. This is for the principal producing countries of the world, and shows a marked change in source of sugar supply since 1840, when 95% of the total was cane-sugar. Among beet-sugar producers Germany and Austria lead with 1,780,000 and 1,120,000 tons, respectively; France and Russia produce 960,000 and 885,000 tons, respectively; and Belgium and Holland, 290,000 and 170,000 tons. All other countries combined add 275,000 tons to the above. Among cane-sugar producers Java stands first with an export of 722,000 tons; then comes Cuba, 400,000; Hawaii, 275,000 and Brazil, 175,000 tons. Louisiana is only credited with 132,000 tons. The beet-sugar production for the world now amounts to 66% of the total sugar production.

THE IMPORT OF RAW MATERIALS for 1900, says the U. S. Bureau of Statistics, is likely to be larger than for any preceding year. For the seven months ending Jan. 1, 1900, the "importation of articles in a crude condition, entering into the various processes of domestic industry," amounted to $169,063,962, against $89,860,326 in the corresponding months ending Jan. 1, 1897. The percentage of manufacturers' material imported in the period named for 1899 was 34.79% of the whole importation, as compared with 24.74% in 1897. In this class of importations the great bulk is made up of raw silk, fibers, wool, Egyptian cotton, crude rubber, wood, tobacco, hides and skins, chemicals, and tin in bars.

RAILWAYS IN ASIA MINOR are reported upon by U. S. Consul M. A. Jewett of Sivas. The railways actually in operation are given as follows, but without lengths of line: From Scutari, opposite Constantinople, to Angora, with a branch at Eski-Sher, to Kouleh, connecting with a line to Smyrna. Two other lines from Smyrna lead to the north, to Soma, and to the east, by way of Aidin, to Diuair. With a short line to Brusa, from the Sea of Mamora, and another from Mercina to Adana, these constitute the existing lines. The late German concession, of which so much is said, would extend the Scutari-Konieh line, by way of Marash, Aleppo and Bagdad, to Bassorah, near the mouth of the Euphrates, and thence to the Persian Gulf. This German line follows down the valley of the Euphrates to Bagdad, from a point a little beyond Marash. A proposed railway would start at Samsoun, on the Black Sea, connect at Sivas with a line leading west to Angora and Scutari, and also pass southeast to Harput, cross the Euphrates and follow the Tigris River valley to Bagdad, where it would connect with the German line. In Syria, there are also two short lines in operation, not included in the above systems. One is from Jaffa to Jerusalem, the other connects Beirut and Damascus, and then passes south to later connect with Haifa, on the coast.

A TORPEDO-FINDER, to locate lost torpedoes or any sunken object, has been invented by Thos. J. Moriarty, of Newport, R. I. The device confines within a buoy a reeled-cord connected with a casing fitted in the torpedo, or to any other object. In this casing is clockwork which withdraws a releasing bolt and brings into action a piston which is operated by the water pressure. This clockwork is set to work at any depth, and when the torpedo reaches this point, the piston releases the buoy; the small rope then brought up is attached to a stout cable securely anchored in the torpedo by which it may be lifted. Mr. Moriarty was formerly model maker at the torpedo-station at Newport and arrangements are being made to try his device with a Whitehead torpedo.

MOUNT McKINLEY, in Alaska, says Mr. Henry Gannett, of the U. S. Geological Survey, is 20,464 ft. high, and is the highest mountain within our territory. This mountain was formerly known as Mount Allen, and it was called Tralega by the Indians. In the same bulletin, soon to be issued, Mr. Gannett gives the official height of other mountains, as follows: Mount St. Elias, 18,024 ft.; Wrangel Mountain, 17,500 ft.; Mt. Blackburn, 12,500 ft.; Black Mountain, 12,500 ft.; Mt. Cook, 13,700 ft.; Mt. Crillon, 15,900 ft.; Drum Mountain, 13,300 ft.; Mt. Fairweather, 15,292 ft.; Mt. Hayes, 14,500 ft.; Iliamna Peak, 12,066 ft.; Mt. Kimball, 10,000 ft.; Mt. La Perouse, 10,740 ft.; Mt. Lituya, 11,852 ft.; Mt. Sanford, 14,000 ft.; Seattle Mountain, 10,000 ft.; Tilman Mountain, 13,300 ft.; Vancouver Mountain, 15,666 ft.

FURNACE HEATING FOR SCHOOLHOUSES having over eight rooms is not considered good practice by Prof. F. W. Chandler, Consulting Architect to the Mayor of Boston; T. J. Waters, Chief Engineer of the Board of Education of Chicago; Wm. M. Mannes, Engineer Assistant to the Superintendent of School Buildings, New York, and J. D. Cassell, Inspector of Heaters, Board of Education, Philadelphia. The question was referred to Professor Chandler after ex-Mayor Quincy, of Boston, had vetoed an order to heat a new grammar school by means of a hot-air furnace, on the ground that the system should not be used for buildings having more than eight or ten rooms. The Boston "City Record" for Jan. 4, 1900, devotes nearly two pages to a report on the subject by Professor Chandler and the opinions of the other gentlemen named above. Mr. Waters gave some interesting figures for two school buildings erected in Chicago in 1894, each containing eight class rooms and an assembly room equal to two class rooms, one being heated by steam and the other by hot air. The cost of installing steam heating and mechanical ventilating apparatus was $5,188, against $3,200 for furnace heat and natural ventilation. The figures for coal during two years in the two buildings were as follows:

Steam-Heated Building.

1896-7, 372,710 lbs. bituminous coal, at $2.30 per ton. $429
1897-8, 440,175 lbs. bituminous coal, at $2.05 per ton. 451

Furnace-Heated Building.

1896-7, 393,435 lbs. anthracite coal, at $5.60 per ton. $1,102
1897-8, 297,250 lbs. anthracite coal, at $5.72 per ton 850

The repairs from 1894 to the close of 1899 were only $85 for the steam-heated building against $454 for the one heated by furnace.

railways interested to remove their tracks and structures from the site within the time required by the contract. The substructure is now, however, practically completed and work on the superstructure will shortly be commenced. The general contract was let to the Scherzer Rolling Lift Bridge Co., of Chicago; the substructure was built by McArthur Bros., of Chicago; and the superstructure will be built by the A. & P. Roberts Co. (Pencoyd Iron Works), Philadelphia, Pa.

(3) A double-track bridge crossing the Chicago River just above Taylor St., Chicago, on a skew of 36° 30′, and carrying the approach tracks of the Grand Central Station. Span, 275 ft., c. to c. of bearings; clear waterway (on the square), 120 ft. Provision is made for eventually making this a four-track bridge. The contract for the substructure and superstructure has been let to the Pennsylvania Steel Co. (Eng. News, Nov. 2, 1899.)

(4) A highway bridge at Chicago, carrying Taylor St. across the Chicago River on a skew of 74° 10′; span, 150 ft.; clear waterway (on the square), 120 ft. The superstructure will be built by the Chicago Bridge & Iron Co., and the substructure by Fitz Simons & Connell (Eng. News, Nov. 2, 1899).

(5) A single-track bridge for the Cleveland, Cincinnati, Chicago & St. Louis Ry., at Cleveland, O., crossing the Cuyahoga River. It has a single leaf, with a span of 125 ft., c. to c. of bearings, giving a clear waterway (on the square) of 110 ft. The railway company will build the substructure and the Pennsylvania Steel Co. will build the superstructure.

Four of these eight bridges are through bridges, and all but two have double arms or leaves, meeting in the center of the span. The exceptions are the Boston and Cleveland bridges, each of which has single arms, extending across the water.

The project of the Boston Terminal Co., by which one immense terminal has been substituted for four separate terminals, was described in our issue of Jan. 14, 1897, and the progress of the work was recorded in our issue of July 8, 1897. The station is now in use, and the new bridge is now nearly completed. Some special designs of bridges swinging in a horizontal plane were at first considered, but eventually a bridge of the Scherzer type was adopted, largely owing to the necessity of occupying as little ground as possible, and of securing rapidity of operation. The total width of channel, between harbor lines, is 240 ft., but there are six piers, three on each side of the 42-ft. navigable channel. The piers carry plate-girder deck spans, and the plate-girder spans on the east side of the channel support the operating machinery of the draw or "rolling-lift" span. These eastern fixed spans are included in the contract for the draw-bridge. Four of the tracks form the approach to the main floor of the trainshed, while the other two connect with the loop terminal for suburban trains on the basement floor.

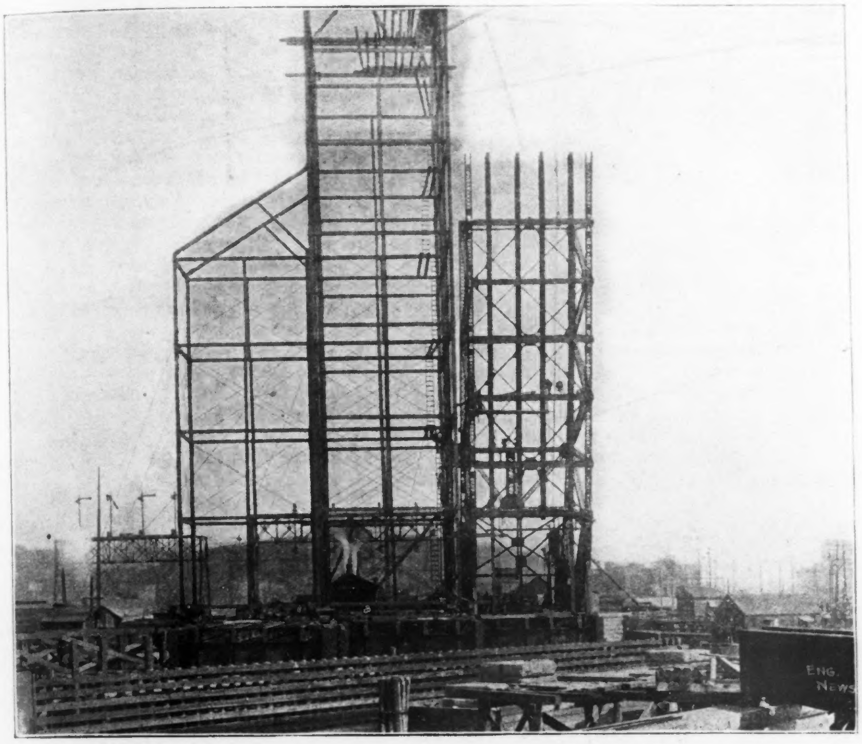


FIG. 13.—VIEW OF ROLLING-LIFT DRAWBRIDGE DURING ERECTION.

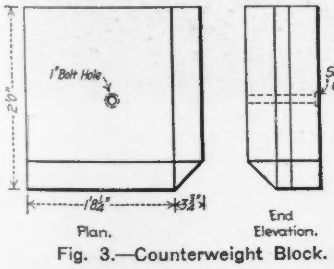


Fig. 3.—Counterweight Block.

Fig. 1 is a general plan and elevation of the structure, and shows clearly its great angle of skew. The bridge consists essentially of three double-track bridges, each complete in itself, and each fitted with its own operating mechanism, the three bridges being coupled together by connecting links coupled to pins in the top chords of the adjacent trusses. Behind each lift span is a framing which carries the machinery and the back end of the operating strut, the front of the strut being coupled to a pin over the center line of the bridge. A curved roller path for the strut gives it the proper vertical motion to conform to the movements of the point of attachment. A heavy counterweight on each truss greatly reduces the actual load to be overcome by the operating machinery.

Owing to the skew and to the arrangement of the piers, the trusses of each span are of unequal length. The shorter one has a span of 83 ft. 8¼ ins., while the longer one has a span of 113 ft. 10¼ ins. The total weight is 4,685,000 lbs., of which 1,755,600 lbs. are counterweight metal.

The numbers on Fig. 1 indicate the several members of one of the longer trusses, A; and the accompanying table gives the strains in these members and shows their construction. The shorter trusses, B, are of similar design, but the inclined member (S) is the end post, the panel (1), (2), (3), being omitted. This makes Truss B 30 ft. 2 ins. shorter than Truss A. The conditions for calculations were as follows:

(1) Live Load.—Two 131-ton locomotives (with tenders), followed by a train weighing 4,000 lbs. per lin ft.

(2) Dead Load; Truss A.—Long arm (exclusive of member No. 17), 196,600 lbs., center of gravity (K); this includes weight of floor and bracing carried by Truss A. Short arm (incuding member No. 17), 93,450 lbs., center of gravity (L). Counterweight, 354,000 lbs., center of gravity (M).

(3) Truss A bears at (X), (Y) and (Z) before being loaded.

(4) No bearing moves vertically during loading.

(5) Truss A is held at one of three bearings and slides on two others horizontally, without friction during loading.

(6) All members of Truss A have the same modulus of elasticity.

(7) The stresses for live load and temperature are figured with regard to the length and sectional area of all members of the truss, and not for a uniform moment of inertia.

Fig. 2 shows the construction of one of the shorter trusses, B, from which it will be seen that the structure is entirely of riveted work, with floor beams below the bottom chords, and with large gusset plate connections. The floor beams are riveted plate girders. The end floor beams, shown on Fig. 2, are 40 ins. deep at the ends and 54 ins. at the middle. All the others have parallel chords or flanges. Between the floor beams are four lines of 30-in. plate girders forming the track stringers, which rest on angle brackets and are secured to the webs of the floor beams by vertical angle iron brackets or knees. It will be noted that all the connections are heavily riveted, in accordance with the standard specifications of the N. Y., N. H. & H. R. R. The heel or rolling segment of the truss is a heavy segmental double-web plate girder, or box girder, with a straight top flange and a radius of 26 ft. for the track plate of the lower chord.

The counterweight box for Truss B is a vertical rectangular girder 20 ft. 3⅞ ins. long and 18 ft. 4⅛ ins. deep, with a width of 18 ins. over the flanges. It is divided into compartments, and the web has holes for 1-in. bolts attaching the cast-iron counterweight blocks, which are placed on each side of the web. These blocks are 24 ins. square and 9¾ ins. thick, weighing about 1,400 lbs. each. The counterweight box and the blocks for Truss A, are larger. On each truss, the counterweight rests upon the top of the segmental girder, and is tied to the top chord of the truss by a triangular trussed tie member (18), riveted to the connection plate. Fig. 3 shows one of the blocks, which also appear in place in the half-tone engravings, Figs. 14 and 15.

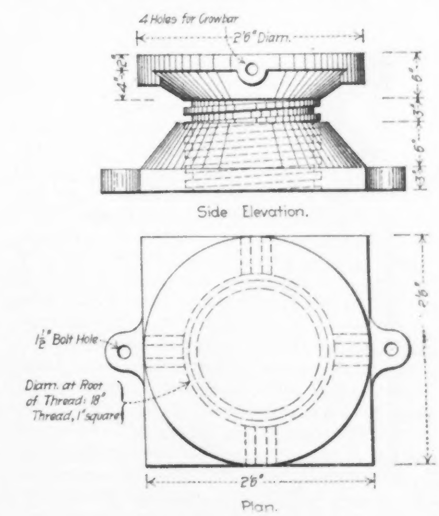


Fig. 5.—Pedestal Cap.

Fig. 4 shows one of the connecting links for coupling the separate double-track bridges together to form one structure. It is of box section, with top and bottom troughs (each composed of

ROLLING LIFT BRIDGE AT THE BOSTON TERMINAL (N. Y., N. H. & H. R. R.).

(With two-page plate.)

The most common type of drawbridge, whether for railway or highway traffic, is that in which the bridge swings horizontally upon an end or center pivot, but this type presents some very serious disadvantages, especially for large bridges where the stream and the bridge carry a heavy traffic, or where the banks of the stream are used as berths for vessels. In the first place, it is impossible to move a long and heavy structure of this kind at any but a slow speed, and the moving weight cannot be counterbalanced or reduced. The swing-bridge also requires a considerable space to be kept clear on each side, so as not to foul vessels lying at the wharves or approaching the bridge, and its center pier and guard pier form obstructions to navigation. With a shore pivot, also, a sufficient length of the river bank must be kept clear to admit of the sweep of the shore end of the span, and to receive the swing span when open for navigation. In addition to this, if bridges occur at frequent intervals (as for instance in Chicago), it may happen that they will be so close together that two swing bridges cannot be opened at the same time.

To obviate these difficulties, different forms of bascule bridges have been introduced, which swing in a vertical plane, can be counterweighted, can be operated rapidly, and at no time occupy more of the river or shore than is covered by the width of the bridge. They also in many cases obviate the necessity of putting a pivot pier in the channel. An interesting type of bascule bridge which has been introduced within the past few years is the Scherzer rolling-lift bridge, in which each span or half-span rolls back upon its curved heel on a track laid on the abutment. This system was invented and patented by the late Mr. Wm. Scherzer, M. Am. Soc. C. E., who died in 1893. The first bridge of this system is that which crosses the Chicago River at Van Buren St., which was opened in 1895, and was described and illustrated in our issue of Feb. 21, 1895. It is 115 ft. span, c. to c. of bearings, giving a clear channel of 109 ft. between masonry abutments. This replaced an old center-pivot swing bridge, and was adopted partly to give a better channel for navigation and partly because a bridge was to be built just below it, and which would have been fouled by a swing bridge. The contract for the superstructure was let to Mr. A. Gottlieb, and after his death the work was carried on by Mr. C. L. Strobel, M. Am. Soc. C. E. The substructure was built by Fitz Simons & Connell. The second bridge was that referred to as being close to the Van Buren St. Bridge. This structure is a four-track bridge of 114 ft. span, with a waterway of 108 ft., and carries the Metropolitan Elevated Ry. It consists of two double-track bridges placed side by side and normally coupled together, but they can be disconnected and operated separately if necessary. This bridge was opened in May, 1895. The superstructure was built by the Lassig Bridge & Iron Co., and the substructure by Fitz Simons & Connell. The third bridge carries North Halstead St. across the Chicago River, and this was described in our issue of Sept. 9, 1897. It has a span of 127 ft. c. to c. of bearings, and a waterway of 121 ft. The superstructure was built by the King Bridge Co., of Cleveland, and the substructure by Wilson & Jackson, of Chicago.

Five other Scherzer bridges are now under construction, as follows:

(1) A six-track bridge, on a skew of 42°, over Fort Point channel, at the end of the new yards of the Boston Terminal Co., Boston, Mass.; span, 83 ft. 8¼ ins.; clear waterway (on the square), 42 ft. This bridge is now practically completed, and is described and illustrated below.

(2) An eight-track bridge, on a skew of 68° 21' 40", crossing the Chicago Drainage Canal at Campbell Ave., Chicago; span, 150 ft., c. to c. of bearings; clear waterway (on the square), 120 ft. (Eng. News, Dec. 30, 1897; April 7, Oct. 20 and Nov. 10, 1898). Great delay in the prosecution of the work has been caused by the failure of the

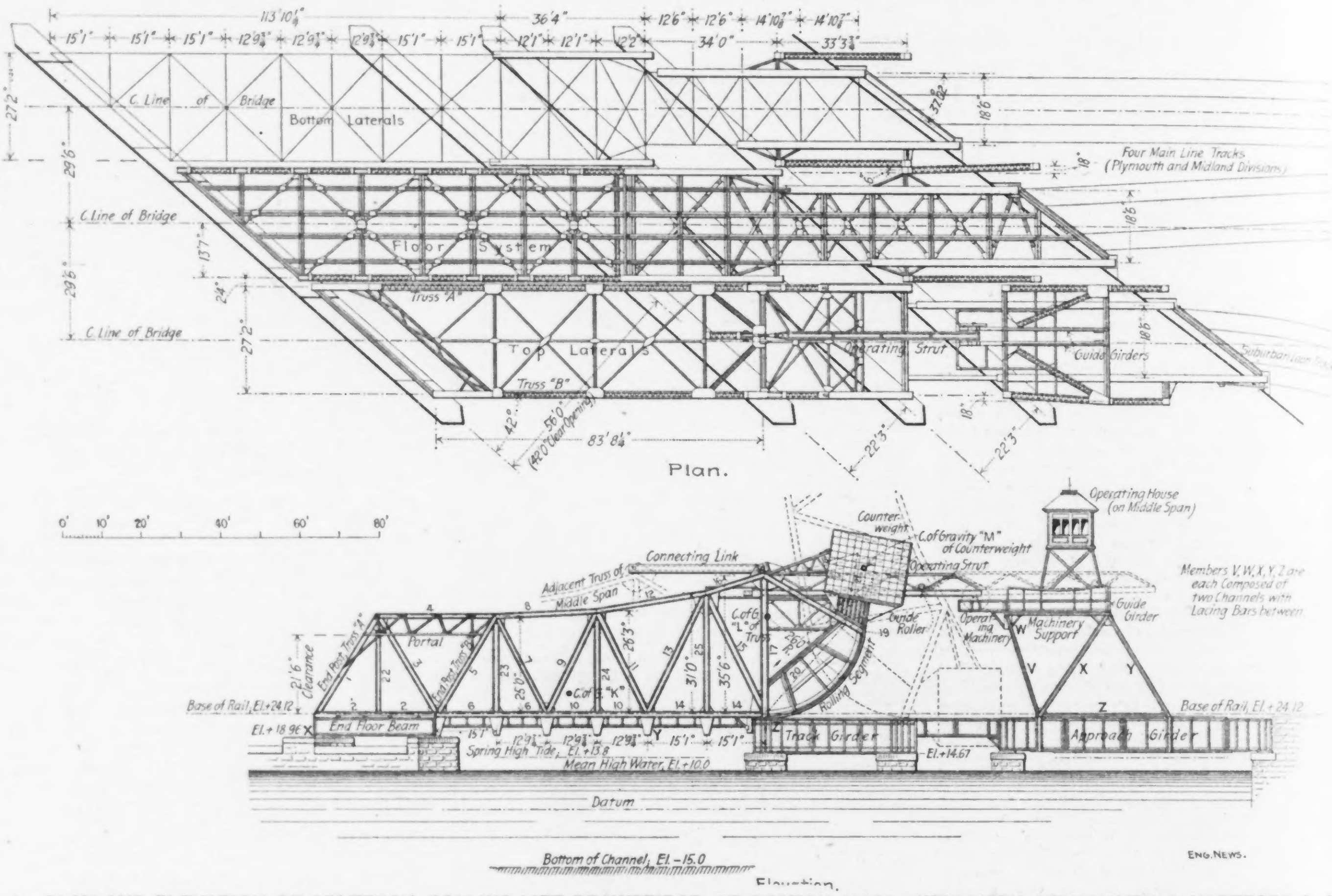


FIG. 1.—PLAN AND ELEVATION OF SIX-TRACK ROLLING-LIFT DRAWBRIDGE, AT BOSTON, MASS.; NEW YORK, NEW HAVEN & HARTFORD R. R.

Table of Stresses in the Longer Truss (114 ft. 3¼ ins.) on Three Supports.

Member.	Load: Dead.	Load: Live; plus 12.5% for impact		Temp. stress for 50°F. excess in top chord.	Stress: Maximum		Stress: Unit.	Area: Net.	Area: Gross.	Sections.
1.	+ 11,000	− 151,500	....	− 32,600	− 173,100	+ 11,000	7,300	23.7	26.40	2 Pl. 15×3/8, 1 " 18×3/8; 4 Ls. 3×3×3/8
2.	− 5,400	+ 80,000	....	+ 17,000	+ 96,600	− 5,400	8,740	10.5	19.65	2 " 15×3/8; 4 " 3×3×3/8
3.	− 48,400	+ 123,000	− 32,000	+ 32,600	+ 107,200	− 80,400	5,630	19.0	22.75	2 " 15×3/8; 4 " 4×3×7/16
4.	+ 31,000	− 146,500	....	− 34,200	− 149,700	+ 31,000	7,280	20.6	22.25	2 " 15×3/8; 4 " 3×3×1/2
5.	+ 69,600	+ 77,500	− 65,000	− 32,600	+ 147,100	− 28,000	8,150	18.0	20.97	2 " 15×3/8; 4 " 3×3×7/16
6.	− 66,900	+ 138,000	....	+ 50,800	+ 121,900	− 66,900	6,530	18.7	22.25	2 " 15×3/8; 4 " 3×3×1/2
7.	− 97,300	− 138,000	+ 27,000	+ 27,600	− 235,300	....	7,350	32.0	33.24	2 " 20×1/2; 4 " 5×3×7/16
8.	+ 110,800	− 94,500	....	− 63,500	+ 110,800	− 47,200	7,080	15.7	19.65	2 " 15×3/8; 4 " 3×3×3/8
9.	+ 115,900	+ 193,000	− 11,500	− 27,600	+ 308,900	....	9,000	34.3	39.44	2 " 21×1/2; 4 " 5×3×3/8
10.	− 161,000	+ 28,500	− 8,800	+ 75,200	− 169,800	....	7,850	21.6	21.60	2 " 15×7/16; 4 " 3×3×3/8
11.	− 118,100	− 246,500	+ 1,100	+ 16,000	− 364,600	....	7,300	49.9	53.10	2 " 22×3/4; 4 " 5×3×11/16
12.	+ 217,100	+ 85,500	− 3,950	− 83,500	+ 302,600	....	9,000	33.6	40.90	2 " 15×3/4; 4 " 5×3×5/8
13.	+ 138,400	− 162,000	....	+ 101,000	+ 239,400	− 23,600	8,560	28.0	33.50	2 " 18×5/8; 4 " 3×3×1/2
14.	− 273,400	− 39,500	+ 31,500	+ 37,800	− 312,900	....	7,800	40.1	40.90	2 " 15×3/4; 4 " 5×3×5/8
15.	− 108,000	− 86,500	− 7,100	− 85,500	− 287,100	....	7,070	40.6	43.44	2 " 20×5/8; 4 " 5×3×5/8
16.	+ 335,200	....	....	....	+ 335,200	....	9,000	37.2	42.60	2 " 15×3/4; 4 " 5×3×11/16
		+ 30% for impact.								
22.	+ 9,500	+ 78,000	....	....	+ 87,500	....	9,000	3.7	11.76	2 10-in. 20-lb. channels.
23.	+ 17,600	+ 135,000	....	....	+ 152,600	....	9,000	16.9	19.80	2 15-in. 33-lb. "
24.	+ 16,200	+ 130,000	....	....	+ 146,200	....	9,000	16.3	19.80	2 15-in. 33-lb. "
25.	+ 18,900	+ 140,000	....	....	+ 158,900	....	9,000	17.7	20.58	2 15-in. 35-lb. "
	Tail end portion of truss; stresses.									
	Closed.	Half open.	All open.							
16.	+ 335,200	+ 198,000	+ 18,000	....	+ 335,200	....	.....	....	.....	
17.	− 184,500	− 35,000	+ 215,000	....	+ 215,000	− 184,500	5,130	41.9	50.10	2 Pl. 20×3/4; 4 Ls. 5×3×11/16
18.	+ 102,400	+ 228,000	+ 257,000	....	+ 257,000	....	9,000	29.8	33.7	........; 4 " 6×6×3/4
19.	+ 249,700	+ 28,000	− 260,000	....	− 260,000	− 249,700	4,250	61.2	64.19	4 Pl. 22×1/2; 4 " 5×3×11/16
21.	− 418,500	− 278,000	− 128,000	....	− 418,500	....	.....	....	.....	To suit counterw't sup'rts.

PIPE-CONNECTED SIGNALS FOR MECHANICAL INTERLOCKING.*

By G. S. Pflasterer.†

Pipe-connected signals were first used on the Pennsylvania R. R. in 1874, and for about ten years were the general and accepted practice for both home and distant signals. About 1884, after unlimited difficulties in getting wire suitable for the purpose, wire-connected signals were introduced, because they were thought to be a more economical appliance. Have they proved to be economical and safe? I do not think so. We need something that will give better satisfaction and increase the safety of our signaling appliances. They cannot be made too safe, and the better service resulting will warrant the extra expense in installing pipe-connected signals. As the cost of maintaining them is so much less than the wire-connected signal, they are, by long odds, the cheapest in the end.

I am convinced that we have found satisfaction in pipe-connected signals, so far as their use is concerned, on the Chicago & Eastern Illinois R. R. My experience is limited to pipe-connected home signals; but I would recommend that the distant signals be pipe-connected also. I am not a firm believer in distant signals, unless they are so connected, when manually controlled.

The pipe-connected signal is ready to respond to the action of the lever when required and at all times. The towerman does not suddenly find himself without power to allow the fast train, which has shown up just beyond the distant signal, to proceed safely over the interlocking without stopping. If the train is stopped the towerman is liable to do something he should not do in his excitement to get the train through with as little delay as possible. The pipe-connected signal gives a concise and clear cut indication at all times, whether in the clear or danger position, according to the position of the lever operating such signal. There is no half-way indication about it. If trouble does arise, which is at very infrequent intervals, and perhaps then only on account of the bolt lock being adjusted too closely, the towerman or repairman can find the trouble more easily than with the wire-connected signal.

Again, with the anticipated change from a white to a green light for a clear signal, which I think will be universally adopted in the near future, it is at once proper and desirable to have a signal that can be depended upon to give the proper indication, as operated from one position to the other. The proper indications can only be depended upon with pipe-connected signals. Some have doubted the action of the signal should a break occur in the pipe line, believing that with such a break the signal would not restore itself to the normal or danger position. I made the following test to determine the action of a signal in such a case. I selected a signal which has 475 ft. of pipe and all other necessary attachments, cranks, compensator, bolt lock, etc., etc., from top of pole to and including the lever; 70 ft. of this line is on a 12° curve and 65 ft. is a transverse line across tracks to signal. The action of the signal was as follows:

Set in the clear position and disconnected at crank, it immediately went to danger. This was repeated at bolt lock, compensator and at lead-out, from the lever, leaving rocking shaft attached. The result was the same, and each time carrying a heavier load than before. The 14-lb. counter weight on balance lever is so adjusted as to give the least possible resistance to the clearing of the signal, but can be adjusted to give greater resistance, according to the length of line operated; or, in other words, it can be made more effective in case of a break or disconnection in the line. It is, of course, a matter of construction as to whether it will take 10 lbs. or 40 lbs. to restore a signal to the danger position, on the length of line above stated.

The pipe-connected home signal costs approximately 30% more for installation than the wire-connected signal, but approximately 80% less for maintenance, notwithstanding such repairs as would be necessary in case of a derailment which would tear up pipe lines, foundations, etc. It is seldom, if ever, that a pipe-connected signal needs any adjusting, if properly compensated; except in a very few special cases, when they would perhaps need as close watching as a wire-connected signal, in the matter of adjustment only.

Pipe-connected signals produce the highest efficiency of service, while the wire-connected signals produce exactly the opposite. They are a constant source of trouble to the signal and operating departments of railways on account of frequent failures from broken wires, freezing fast in low places in winter time, and the constant watching necessary by towermen and repairmen to keep them working and properly adjusted. A repairman's services are often needed to remedy some one of the many defects of the wire-connected signal. This sort of thing is expensive when a repairman is perhaps 50 or 100 miles from where he is needed one day, and the next day he is wanted somewhere else equally as far away.

Every time a signal is out of service on any account we imperil the safety of our trains, as I have before explained. The following will serve to show the average relative pulling power required to operate pipe and wire-connected signals:

Signal.	Av. length of line.	Connection.	Av. pulling power required
Home	450 ft.	Pipe.	83 lbs.
Home.	450 "	Wire.	80 "
Distant. .	1,650 "	Wire.	180 "

*Abstract of a paper read at the meeting of the Railway Signaling Club, at Chicago, March 13.

†Foreman of Signals; Chicago & Eastern Illinois R. R.

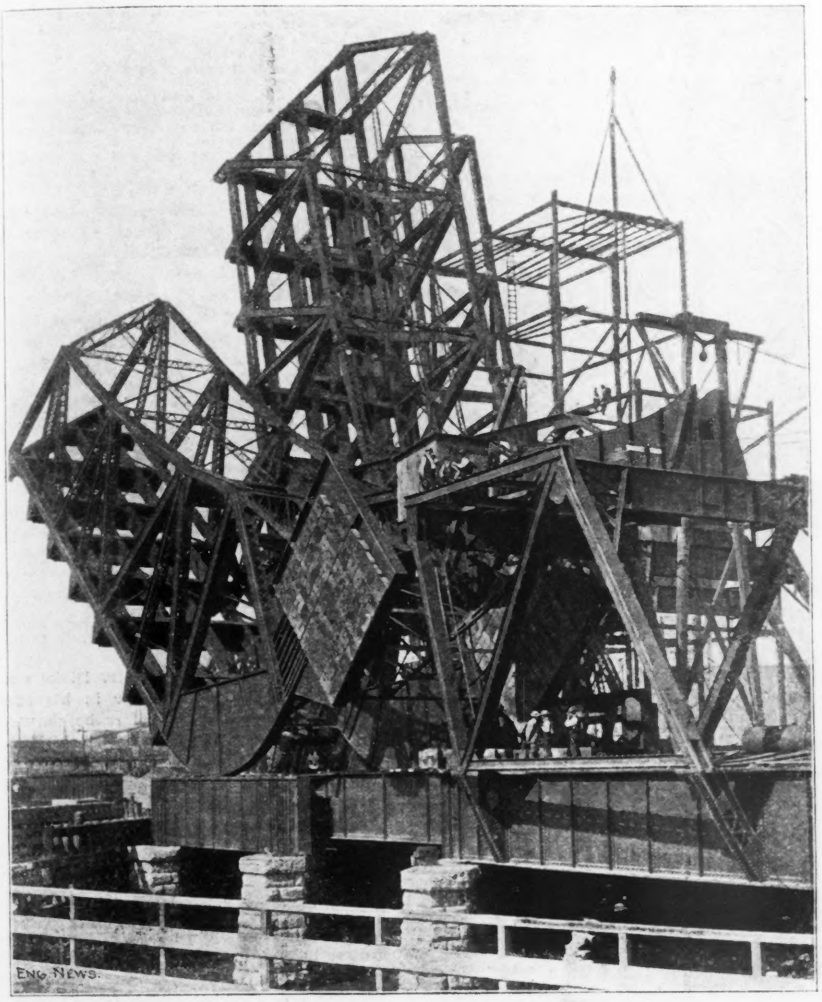


FIG. 15.—VIEW SHOWING ONE LEAF HALF OPEN AND THE OTHER TWO LEAVES FULL OPEN.

CONCERNING CERTAIN CURIOSITIES.

We have recently been favored with a circular of the Prentice Investment Co., Edison Building, 44 Broad St., New York city, giving a prospectus from which we take the liberty of quoting verbatim as follows:

PROSPECTUS OF
THE POWER MULTIPLYING ENGINE COMPANY
OF NEW YORK. CAPITALIZATION, $2,000,000.
OFFICERS:

Thomas A. Edison, Jr. ....President.
William Holzer ....Vice-President.
(For 12 years General Superintendent of Thomas A. Edison Electric Light Co., Menlo Park.)
J. A. Thompson ....Treasurer.
G. H. Goebel ....General Manager.
H. L. Prentice ....Secretary.

A PERFECT SYSTEM OF PNEUMATIC POWER TRANSMISSION.
Adaptable to
FACTORIES, STEAMSHIPS, STEAM, STREET OR ELEVATED ROADS.

The following experts and mechanical engineers have examined the Pneumatic system and reported favorably upon it: W. Barnet Le Van, M. E., Member of the Franklin Institute, Philadelphia, Pa.; Barton H. Jenks, M. E.; Thos. Shaw, M. E., and many other scientists and engineers.

Many years of practical experimenting has enabled the inventor to make operative a force provided by nature—to obtain from air the power, combined with cheapness, which has so long been sought for. He has proved that horse cars can be run at an expense of twenty cents per day, and larger cars at a slightly increased rate, by means of pneumatic propulsion.

While developing these results he has discovered a power multiplying engine, which will furnish unlimited power at very small cost. A little coal used for starting purposes will produce almost incredible results. The engine once started can be kept in operation, and power increase at the most trifling expense. A small steam boiler, requiring scarcely half a ton daily, operates an air-power creator, which in its turn gives a twenty horse-power engine, from which one horse power is taken to operate by belt another air-power creator, which again gives twenty horse power, less the one used to operate the second air-power creator. By continuing or extending this plan the power can be indefinitely increased, so that a steamship or factory of any size can be run at a cost of three tons of coal per week.

For the purpose of making demonstrations and proving the commercial value of this newly-discovered method of increasing power, a small amount of stock will be offered at $5.00 per share, par value $20. The price of stock will be advanced to par immediately after the completion of the commercial plant.

The name of Edison is of world-wide fame. We wonder how many ignorant and credulous men will be induced to invest in the above-described swindle in the belief that the Edison whose name is given as the President, is the famous inventor himself. The cunning use of Mr. Holzer's name, with a reference to Menlo Park, and the location of the offices in the Edison Building, show evidence of design in this matter.

It is proper to say here that the attempt to make capital out of the famous name of Edison to further such a scheme as this, deserves severe public condemnation, if not more serious punishment. We may also note that the use of the name of the Franklin Institute in the prospectus deserves like condemnation, especially as we have the best of reasons for believing that the use of Mr. Le Van's name in connection with this scheme is entirely unauthorized.

Concerning Mr. Thos. A. Edison, Jr., his associate, Mr. Holzer, and the Prentice Investment Co., our readers may recall that the same parties were before the public not long ago exploiting a wonderful secret process of treating steel to which credulous investors were invited to subscribe. Mr. Thos. A. Edison, Jr., was alleged to be the inventor of that process; but he is not claimed to be the inventor of "the power-multiplying engine." Was there any reason, then, for putting his name as the President of the company save two over-lapping angle irons), and side plates ½ x 24 ins. In section it is 24 ins. deep and 7 ins. wide, reduced to 6 ins. in width at the ends. In each end is fitted a flanged steel casting with a bronze bushing for an 8-in. pin, the outer end of which is tapered and has a square neck 4½ x 4½ ins., which fits a square hole in the plate riveted to the outside of the truss (Fig. 2).

Owing to the skew of the bridge, the end of the second floor beam from the rolling girder on Truss A (at the junction of members (11) and (13). Fig. 1), comes over one of the piers, and is fitted with a foot or pedestal bearing upon the pier. A ⅝-in. planed base-plate is riveted under this end of the beam, and when the bridge is closed this takes a bearing upon the adjustable cap, Fig. 5. The pedestal is a heavy box girder, 30 x 39 ins. on top and 30 x 56 ins. on the bottom, 2 ft. 10 ins. in height. On the top is a steel casting or nut for the threaded cap or bearing, the cap being planed to fit the planed base-plate on the floor beam.

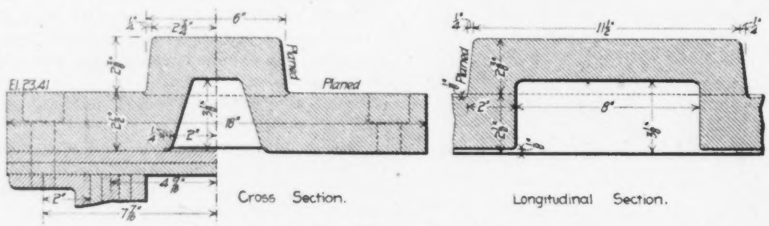


FIG. 7.—TEETH OF RACK.

The rolling span rolls back upon one of the plate girder approach spans, and Fig. 6 shows the construction of one of the heavy double-web plate girders of these fixed approach spans. It is 40 ft. 4 ins. long, 8 ft. 3¼ ins. deep, over the flange angles, and of very heavy construction. There are two web plates ¾ x 99¼ ins., and the top and bottom chords are each composed of three horizontal plates, six vertical or reinforcing plates and two flange angles. Plate girder floor beams connect the girders. This figure also shows the construction of the cast-steel rack which is bolted upon the top chord of each girder, and the teeth of which engage with the slotted track plate on the segmental or rolling girder, Fig. 2. The form of the teeth of the rack is shown in Fig. 7.

Behind each double-track bridge is a tower formed by two side-frames which carry the floor upon which is mounted the machinery and the curved guide girders for the operating strut. The vertical frames of the towers are outside the approach girders, Fig. 1, and rest upon inclined bracket posts, the feet of which are riveted to the webs, while the upper ends are held by horizontal gusset plates riveted to the top chords of these girders. The operating strut, Fig. 8, is a trussed girder, 60 ft. 1 in. long and 5 ft. deep. Between the two 15-in. channels of the bottom chord is riveted a cast-steel rack, 19½ ins. wide, with teeth 16 ins. wide. The rack is in four pieces, each 12 ft. long, with 26 teeth, the pitch being 5.54 ins. The front end of the strut is attached to a transverse member between the trusses by a 7 3-16-in. pin, while its rear is supported by two 8-in. flanged wheels, placed above the bottom chord and running on the curved guide girders shown in Fig. 1. The rack gears with a 30-in. operating pinion, as shown in Fig. 9, the pinion shaft being journaled in bearings bolted to the machinery floor. On top of the journal frames are 9-in. flanged wheels (A) which bear against track bars (B) on the face of the chord channels, and thus prevent the strut from rising so as to throw the rack out of mesh with the pinion.

Each double-track structure is fitted with its own operating machinery, so that it can, if at any time necessary, be operated independently. Fig. 10 shows the arrangement of this machinery. A 50-HP. electric motor drives the gearing through the medium of the pinion (I) and spur wheel (H). The latter is keyed to a shaft carrying the pinion (D) which gears with (C) on the same shaft with (B). This latter pinion drives the spur wheel (A) on the shaft of the operating pinion. On the shaft carrying (H) and (D) is also mounted a 4-ft. band wheel, with a face 9¾ ins. wide, having two flat grooves for steel brake bands 3-16 x 3¾ ins. The wheel (H) also drives an idler (G), gearing with a spur wheel (F) and pinion (E), the latter in turn gearing with the wheel (C). The proportions ot the gearing are as follows:

		Pitch		
	No. of teeth.	Diameter, ins.	Circum., ins.	Width of face, ins.
A	72	85.943	3¾	9
B	13	15.520	3¾	9½
C	42	33.420	2½	7
D	15	11.935	2½	12¼
E	13	10.375	2½	7½
F	36	28,647	2½	7
G	24	19.100	2½	7

For locking the bridge when closed, there is an end locking bolt to each truss of the three double-track lift spans. A shaft of 2 15-16 ins. diameter, with flange couplings, is set upon the top of the rest pier, and is driven by an electric motor. On the shaft are six pinions gearing with racks on the six locking bolts. These bolts are 3½ ins. square, 29⅜ ins. long over all, and run on wheels on a base-plate. Their ends are beveled and enter holes 5 x 5 ins. in a grooved casting which receives a plate bolted to the bottom of the end floor beam. This locking mechanism is shown in Fig. 11.

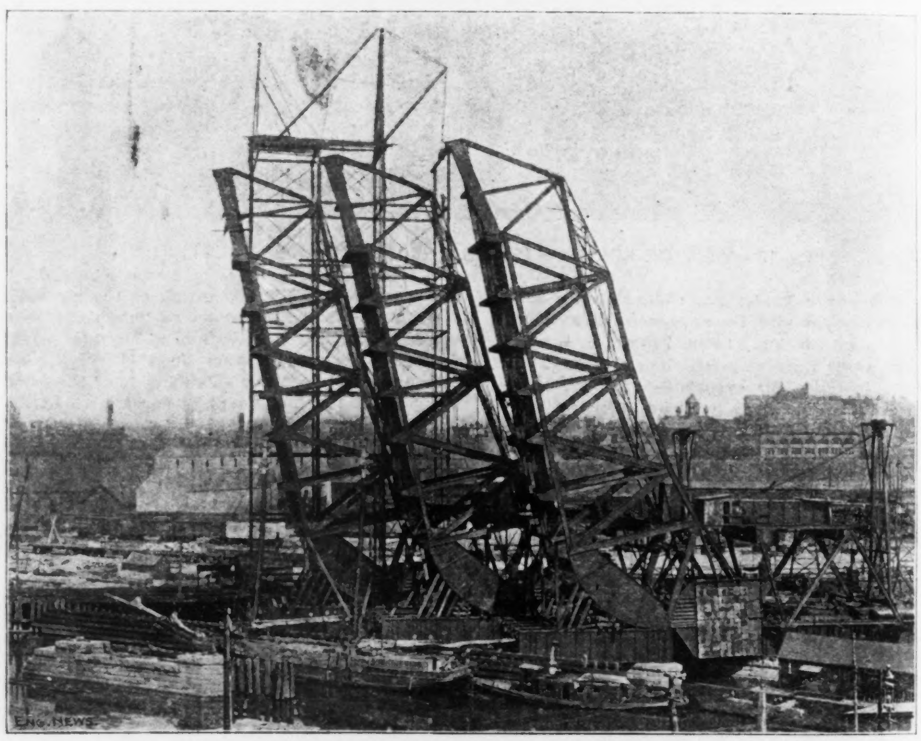


FIG. 14.—VIEW OF BRIDGE COMPLETED AND OPEN.

The rail joint at the end of the bridge comes upon a tie 12 x 8 ins., on the face of the approach span. On the tie are bolted two base-plates, the shore end of each of which has bolted clamps for the fixed rail, while the other end has two ribs 1½ ins. high, with inclined inner faces, forming a flaring channel to receive the projecting end of the bridge rail, as shown in Fig. 12.

Fig. 13 is from a photograph taken opposite the bridge during its construction, and shows the style of erection falsework used. In the background are some of the signal bridges of the terminal yards, and also the front of the great trainshed. Fig 14 shows the bridge completed, with all spans raised. Fig. 15 shows the bridge with one of its leaves partly lowered, and gives some idea of the massive character of the construction. At the right is the stationary tower, resting upon the bracket posts of the plate girder, and upon this may be noted the curved guide girders for the operating strut, one roller of which is just beyond the left-hand end of the girder. To the left of the upper corner of the counterweight box, may be seen the end of the heavy longitudinal girder to which the strut is attached. It will, of course, be understood that, as already explained, in service the three spans or leaves are coupled together and operated as a single six-track structure.

The structure is operated by one man from the house or cabin built on the steel frame tower behind the middle leaf. The time of opening, including locking, is 30 seconds; and the same time is occupied in closing and locking.

The bridge was built for the New York, New Haven & Hartford R. R.; Mr. F. S. Curtis, M. Am. Soc. C. E., Chief Engineer; Mr. W. H. Moore, M. Am. Soc. C. E., Engineer of Bridges. The contractors for the masonry were Holbrook, Cabot & Daly, of Boston, Mass. The contract for the superstructure, with its approach girders and operating machinery, was let to the Pennsylvania Steel Co., of Steelton, Pa. The plans were prepared by and the construction was supervised by the Scherzer Rolling Lift Bridge Co., 1616 Monadnock Block, Chicago. This company owns the patents on this type of bridge, and we are indebted to Mr. A. H. Scherzer, President of the company, for plans and photographs of this interesting structure.

We are indebted to Mr. J. V. W. Reynders Superintendent of the Bridge and Construction Department of the Pennsylvania Steel Co., for the following particulars of the shipping weights of the structure:

	Lbs.
Draw-span proper, exclusive of counterweights.	1,190,000
Counterweights	1,810,000
Total weights of moving structure	3,000,000
Machinery and supports for same	740,000
Plate-girder approaches at rolling end	1,110,000
Plate-girder approach at other end	1,720,000
Total weight, metal work in superstructure..	6,570,000

BIDS FOR THE BRIDGE ACROSS SYDNEY HARBOR, New South Wales, will be received by R. W. Cameron & Co., 23 William St., New York city. The conditions of the competition were noted in our issues of Jan. 18, Feb. 22 and March 8, and are also stated in our advertising columns this week.

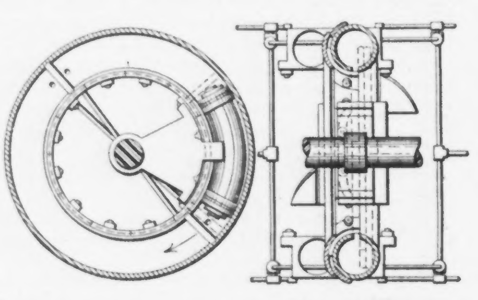
the hope of deceiving ignorant investors by the use of a famous name?

And now a word as to what the "power-multiplying engine" is: Readers of Engineering News may recall an article in our issue of April 6, 1899, in which we exposed two schemes for multiplying power (or dividing cash). One of these fakes was the Power-Multiplying Engine Co., of 14 South Broad St., Philadelphia. It now appears that the concern whose prospectus is printed above is none other than our old friend in a new location. Same old gag about obtaining unlimited power from Nature's vast reservoir in the atmosphere. Same old stock offered at a great sacrifice to build demonstration plant and convince the world. Same old list of assets, viz., patent on an unworked and unworkable scheme for making a rotary compressed air engine; the past record of the Goebel revival of the atmospheric railway; and wind galore.

We shall not waste much space on this precious outfit; but we do want to call especial attention to the remark in the above prospectus that "The following Experts and Mechanical Engineers have examined the Pneumatic system, and reported favorably upon it: W. Barnet Le Van, Member of the Franklin Institute," etc., etc. We will merely mention that some weeks after the exposure of the Power-Multiplying Engine Co., in our issue of April 6, 1899, Mr. Le Van was in the office of Engineering News, expressed his hearty approval of its enterprise in exposing such swindles, and informed us that the office furniture of the Philadelphia concern had been seized by the Sheriff for non-payment of rent.

In conclusion, we described in our previous article the apparatus by which the alleged power-multiplying was to be effected. We now illustrate it that our readers may see on what a slim basis some of the $2,000,000 corporations of the present day are formed (or are alleged to be formed, for we have strong doubts as to whether the "company" has any existence).

The "engine" is an annular cylinder, in which moves a double piston which is connected to and



turns a central shaft. This cylinder is the tube of the old Goebel atmospheric railway put into a circular form. A more crude and unmechanical device for the production of a rotary engine, it would be hard to devise. As for the multiplication of power, that is effected, according to the inventor, through the remarkable fact that a single small compressor will run any number of these abortions. Hitch on as many as you please, and they all run on as cheerfully as if only one were connected, and each developing the same power. At lease he believes they will, and if anyone else believes it, they will believe anything.

"POLEFORCIA."

We have another old friend here. From across the water there comes to us a thick pamphlet headed: "Poleforcia made by the Multiple-Energizing Momentum Engine." It is none other than the Pole Momentum Engine, which was exploited at Washington, D. C., a few years ago, and which we thoroughly exposed in our issue of April 1, 1897. The pamphlet is written in Mr. Pole's own inimitable style, and we learn at its close that full information can be obtained by addressing "Energizing Momentum Engine, 130 Westminster Bridge Road, S. E., London." If the "full information" is couched in the same language as the pamphlet, we fear our English cousins will make slow progress in their study of "Poleforcia!" We cull the following verbatim from the pamphlet:

We make a rim speed of fly-wheel 88 ft. a second, and by doing rotary foot-pound work, for three revolutions of the main shaft it may suffer a 9-in., more or less, loss of rim-speed per second, giving out horse power which is delivered to the shaft for the weights, of iron in motion, in the rim of one fly-wheel. The little engines appear to restore this loss speed of rim, in less than one revolution of the fly-wheel, although the automatic leaves the wheel open for restoration of speed, for nine revolutions, which means a number of impulses of the piston of the engine. The philosophy of this machine is simply that you can roll horizontally (as in the steam railway) a weight which the same power the adhesion in a locomotive could not possibly lift, besides the piston travel in that locomotive is a shorter distance than the movement of the load. (By being the development of the periphery of a 6-ft. 6-in. driving wheel for 48 ins. piston motion in two cylinders.) We use this law of mechanics for driving a revolvable shaft; by a series of fly-wheels, and we give to this power the new name Poleforcia. A mechanically-made POWER. The eccentric action of the Energising Momentum Engine.

The "eccentric actions" are here plain enough; but they are those of the inventor himself. English investors will do well not to monkey with "Poleforcia" with anything shorter than a ten-foot pole.

Liquid Air Again.

As many of our readers have doubtless noticed, the Tripler Liquid Air Co. is publishing a prospectus in the financial columns of various daily newspapers and offering for sale 100,000 shares of its capital stock at $5 per share. We have repeatedly warned our readers not to invest in any of the numerous liquid air schemes, with which the market has been flooded during the past year or two, unless on the advice of thoroughly competent and disinterested experts. We are obliged to repeat this advice in connection with the huge scheme to which Mr. Tripler has given his name. We have in the past and do now award due credit to Mr. Tripler for his ingenuity and enterprise in developing the process of the liquefaction of air upon a large scale. This journal was the first to describe and illustrate his apparatus in detail. With his extravagant published claims, however, we have no sympathy whatever; and now that they are made in definite form in a public prospectus issued for the sale of stock, it becomes proper that their falsity should be exposed. Taking them up in their order, the prospectus says:

The Tripler Liquid Air Co. absolutely controls all the inventions, rights and appliances of Chas. E. Tripler for the manufacture and utilization of liquid air. The priority and value of these rights constitute a MONOPOLY OF THE FIELD, since no other patents of practical utility have ever been granted. * * * * Chas. E. Tripler, President of the Company, is the inventor of the only practical devices for the production and utilization of air on a commercial scale.

By way of instructive comment on these claims, we may refer to the illustrated description of the Linde air liquefying apparatus at the University of Michigan, in our last week's issue, the apparatus of Dewar, in our issue of Dec. 21, 1899, the apparatus of Hampson, described in our issue of April 14, 1898, in connection with a description of Mr. Tripler's own work, and the large plant of Messrs. Ostergren and Burger, described and illustrated in detail in our issue of June 8, 1899. We might mention others, for it is a well-known fact that the liquefaction of air is a problem on which a multitude of inventors and scientists have been at work during the past four or five years; but the above list of prominent and well-known names is sufficient to warn investors that Mr. Tripler's claim to priority is likely to be sharply contested, to say the least.

Quoting further from the prospectus:

The company has a factory in operation in New York city, where liquid air is being manufactured in commercial quantities, and it is being used daily in leading hospitals and for motive power.

No Longer an Experiment.

Prof. Tripler's discovery—liquid air—has therefore passed the experimental stage and can now be profitably used everywhere for refrigeration and motive power, as well as in numerous other important lines. Its utility and practicability have been demonstrated beyond question.

It is true that Mr. Tripler (where he captured the title of Prof. we cannot imagine) has had for two or three years a liquid air making apparatus in New York city. To call it a "factory" seems rather misleading. As to its use in hospitals, we have no knowledge; but we have very grave doubt as to its use for motive power. We do not mean by this that it is impossible to use it in this way. It will be entirely simple to operate an experimental or exhibition motor with liquid air and to develop considerable power in a small compass. That such use of liquid air can be commercially successful, however, has been repeatedly shown to be hardly within the limits of possibility. The statement that "liquid air can now be profitably used everywhere for refrigeration and motive power," therefore, appears to us highly misleading and absurd. We challenge the promotors of the Tripler company to make public any evidence that will stand the test of scientific scrutiny in support of this claim.

Besides the claims for refrigeration made in the sentence just quoted, the prospectus makes a more specific one as follows:

Practical Uses.

The cost of refrigeration in the United States is estimated at over $150,000,000 annually; by the use of liquid air a saving of over one-half is assured.

As a simple instance, in the shipment of fruit from California, 55 gallons (500 lbs.) of liquid air per car will do the work of 5 tons of ice, with dry air instead of moist air, and will save more than $130 per car in ice and its freight.

This means over a million dollars profit annually, and is but a very small fraction of the immense refrigeration and cold storage business of the country, as well as that of ocean steamships.

For motive power on land and sea, liquid air will produce as great a percentage of saving and relatively greater profits than for refrigeration.

If this means anything, it means that the refrigerating effect of 500 lbs. of liquid air is substantially equal to that of 5 tons (10,000 lbs.) of ice. Here is one definite statement in the prospectus and it is one on which no excuse for error can be accepted. Mr. Tripler has been making and handling liquid air for years. The determination of the heat absorbed by a given quantity of air in changing from the liquid to the gaseous state and warming to ordinary temperatures is a very simple matter. He must have made this test himself again and again, and a false statement as to its results would be strong evidence of a deliberate attempt to mislead the public as to the actual value of the stock which it is asked to buy.

Against the statement of the above prospectus we will set the statement of Mr. A. L. Rice in a paper before the American Society of Mechanical Engineers (Eng. News, Dec. 21, 1899):

Prof. Jacobus and Mr. Dickerson have found the latent heat of air at atmospheric temperature to be about 140 B. T. U.

If we mistake not, the Mr. Dickerson referred to has assisted Mr. Tripler in his experiments, and the latter must therefore be conversant with the results of his work. Now, taking the specific heat of air at one-fourth and the temperature of liquid air at atmospheric pressure as — 312° F. (a figure also due to Mr. Dickerson), we have the total heat units absorbed by a pound of liquid air in evaporating and warming to a temperature of 32° as equal to $140 + \frac{(312 + 32)}{4} = 226$. The heat absorbed by a pound of ice in melting is 143 heat units; hence, according to the above figures, liquid air has a little less than 1.6 times the refrigerating effect of an equal weight of ice. This agrees very well with a statement by a correspondent (who we have reason to believe spoke with full knowledge) in our issue of Sept. 21, 1899, that the refrigerating effect of liquid air is less than 1½ times that of an equal weight of ice.

The contrast between these figures and those of the above prospectus is too significant to require comment. Will Mr. Tripler present public proof of the substantial correctness of his figures? If he can do so, our columns are open to him. Until he does this the enterprise of which he is the responsible head cannot be criticised too severely.

In conclusion, we may note that the prospectus advertises Messrs. Hudson Maxim and Henry G. Catlin as the company's consulting engineers. We have never heard of Mr. Catlin, but Mr. Maxim has published a letter in which he disclaims all connection with or responsibility for the company or the published statement in its prospectus.

We remarked at the outset that the Tripler prospectus was being widely published. One of our subscribers in Minneapolis, sends us a copy of it clipped from a local daily with the following comments:

I shall consider you recreant to your duties as a public benefactor if you do not promptly insert the enclosed with "double leaded head" for the benefit of your many readers who have money to burn (or perhaps money to freeze would be more appropriate).

I have not called as yet upon the gentlemen who represents the syndicate in this city, but so impressed am I with its inherent merits that if be is not in, or if the crowd of investors is so great as to block up the passage, I will throw my money over the transom.

Our curiosity drawer is not yet emptied; but we postpone to another time an exhibit of the rest of its contents.

A REMARKABLE LANDSLIP IN PORTNEUF CO., QUEBEC.

Dr. George M. Dawson, C. M. G., F. G. S., and Director of the Geological Survey of Canada, has presented to the Geological Society of America a paper with the above title that is interesting to engineers having to do with earthwork.

This landslip occurred on May 7, 1898, on the Riviere Blanche,, in the parish of Saint Thuribe, Portneuf Co., Quebec. This river is a small stream occupying a valley, about 1,000 ft. wide, between sloping banks 25 to 35 ft. high. The surface of the country in the vicinity is practically level, and is a terrace-flat of marine Pleistocene deposit, known as Leda clay, and the whole thickness of which is nowhere shown. To the north and adjoining the recent slip is an irregular depressed area, now under cultivation, that evidently marks the site of a much earlier slip of the same character. Still further north, and 50 chains from the recent slip, is a low ridge of boulder clay, which may underlie the Leda clay elsewhere, but does not appear here.

A small runnel of water entered the Blanche valley at the site of the slide, and Mr. Dawson was told that previous to the main slip a small slide had been noted at this point. At 5.30 a. m., on May 7, the soil suddenly began to move and continued in motion for three or four hours. The immediate bank of the river, for a space about 200 ft. front, first gave way, and this break rapidly extended inland, forming an opening through which a great body of clay rushed out into the valley. The width greatly enlarged a short distance back of the river bank, and the sides fell in, until a crater-like hollow, of bottle-shaped outline, was formed opening on the valley by a narrow neck. On entering the valley the clay spread upstream for 500 or 600 ft., backing up the river, but the greater part descended the valley for nearly two miles, filling it for that distance to a maximum depth of 25 ft.

When examined by Mr. Dawson, the actual landslip was represented by a depressed area, bordered by clay cliffs 15 to 30 ft. high, with a maximum width of 1,700 ft. and a greatest length of 3,000 ft.; it covered 86 acres. The floor of this depression showed irregular mounds of clay, with trees, fences, and small pools of water; though it is stated that very little water was seen during the actual movement of the mass. The quantity of material poured out into the Blanche valley is approximately estimated at 93,654,000 cu. ft., or about 5,572,413 tons of 2,000 lbs. The slope of the original surface was only about 10 ft., between the head and the orifice of the slip.

In explaining the catastrophe Mr. Dawson says that the light slope shows that the mass of clay must have acted as a liquid mass in motion. Mr. R. Chalmers, of the Geological Survey, who accompanied Mr. Dawson, suggests that, with an underlying impermeable boulder clay, the lower bed of the clay slip becomes exceptionally saturated and formed a sliding plane upon which the more coherent overlying masses moved down. Mr. Dawson admits that this hypothesis is generally correct in the case of landslips, and something of the kind may here have actually occurred at the bank of the river. But he believes that the great and sudden movement should rather be attributed to the character of the water-saturated mass as a whole; especially, as no evidence was found of any special permeable bed, and no underlying surface of either boulder clay or rock is anywhere exposed.

Specimens of the clay in a nearly saturated condition were carefully examined with the following mean results: Specific gravity 1.912, the equivalent of 119.5 lbs. per cu. ft.; the clay as received was found to be capable of absorbing from 7.0 to 0.2% of additional water; apart from the water it consisted of 35.5% argillaceous matter and 43.3% of silt; when fully saturated it contained by weight 23.5% of water, or nearly 50% by volume.

This large amount of silty matter would render the clay unusually permeable, and Mr. Dawson deems it probable that the water saturated the mass by descending directly through from the surface, in a manner that would not have been possible in the case of the more purely argillaceous clays of the same age usually found. Rankine's "Civil Engineering" says:

The presence of moisture in earth, to an extent just sufficient to expel air from its crevices, seems to increase its coefficient of friction slightly; but any additional moisture acts like an unguent in diminishing friction and tends to reduce the earth to a semi-fluid condition, or to the state of mud.

Mr. Dawson thinks that in this particular instance, the silty clay, surcharged with water, stood in a condition of unstable equilibrium, retaining its solidity merely by virtue of its unbroken molecular texture; and that at the moment in which it became subject to internal movement this texture gave way and the clay lapsed into a nearly liquid mass; the particles rearranging themselves with some freedom in the water previously locked up in the pores.

The particularly interesting point brought out by Mr. Dawson we quote verbatim as follows:

The fact that many clays when once completely dried and are then immersed in water lose their plastic character and crumble down into an incoherent mud shows that the natural texture is an important element in their coherence and plasticity; this is a fact which does not appear to have been fully recognized in connection with experiments on clays and soils.

The high specific gravity of the fluent portion of the mass, in this case, doubtless enabled it to carry the unbroken blocks of clay along that were supplied by the collapsing sides of the crater-like depression. The fact that the great mass of moving material was discharged through a comparatively narrow orifice shows that the bank of the valley was much firmer in character than the clay forming the subsoil of the plain inside the bank. This river bank clay had a better natural drainage and was thus not completely saturated.

There had been no excessive rains preceding the slip, but a great depth of snow lay on the ground during the preceding winter; the records showing a total snowfall in February alone of 44.2 ins. During April, most of this snow melted and the ground thawed and admitted the water—and the landslip followed in May. In regions of the same character, therefore, the only protection against similar disasters appears to be in the form of effective surface drainage; such as will carry off the excess water before it can be absorbed by the clays.

Mr. Dawson refers to several similar occurrences in the same region; and one of these, that on the Maskinonge River in 1840, he ascribes to a practically similar cause, though Sir William Logan thought it was due to an underlying sloping bed of rock—which he could not find.

ECONOMIZING CURRENT BY PROPER HANDLING OF THE CONTROLLER ON ELECTRIC STREET CARS.

"The Motorman as an Element in Street Railway Economy" is the title of a paper recently read before the Engineers' Club of Philadelphia by Mr. Charles Hewitt. He described tests made on four street railway lines in Philadelphia. A number of cars equipped with recording watt-hour meters were put in regular service and passed from one motorman to another. No instructions were given to the motormen, but, on the other hand, care was taken to keep from them a knowledge of the object of the instrument. Records were taken at the end of each trip of the number of passengers carried, condition of rail and other necessary data. It was assumed that, with the same car, same motor, same track and all other conditions the same, the watt-hours used per car-mile would show to what extent different handling of the controller by the different men affected the current consumption. As a result of the experiments the following conclusions were reached: (1) The record for any one man is fairly uniform. (2) A man who is economical at one time is nearly always economical. (3) The difference between the men is due almost entirely to the manner in which they handle the controller. In order to show what could be accomplished under special instructions, one of the motormen was given directions for handling the controller. An average of four trips showed that he used 20% less energy than on the previous day, running in the ordinary way and keeping the same schedule. The excess of the highest over the lowest consumption of energy on the four lines averaged about 45% of the lowest. The author believes it is possible to secure an average saving of current of about 20% by properly instructing the motormen. The general average watt-hours per car-mile observed were 1,163. Allowing for loss in line and track, the output of the station is about 1,300 watt-hours per car-mile. On this basis a car will consume 61,685 kilowatt-hours in a year of 365 days. Assuming a cost of 1½ cts. per kilowatt-hour and a probable saving of 20%, the saving amounts to $185 per car per year.

TAKING UP AND MOVING A WATER-WORKS PLANT FROM GREENSBURG, KAN., TO ALVA, OK. T.

The following description of the methods employed in taking up the water-works plant at Greensburg, Kan., and shipping it to Alva, Ok. T. (see note, Eng. News, March 8, 1900), has been furnished us by the contractor for the work, Mr. E. E. Fitzpatrick, of Wichita, Kan.:

The pipe system included 890 ft. of 10-in., 2,050 ft. of 8-in., 4,310 ft. of 6-in., and 10,200 ft. of 4-in. cast-iron pipe; total, 17,650 ft. This pipe was taken up and unjointed in 17 days, including trenching and back-filling, with a gang of 25 men, which was equivalent to 425 men working one day, or one man removing 41 ft. of pipe in one day. The 10 and 8-in. pipe was raised high enough in the ditch to build fires under each joint. When the lead got warm and the pipe expanded it was "unbuckled" by means of a three-legged derrick, working the pipe up and down. Three such derricks were employed.

The 6 and 4-in. pipe was lifted onto the bank, heated a very little, and unjointed by means of jack screws and clamps. A loose wooden clamp was placed against the bell to be pulled off, and one end of a jack-screw against this. The other end of the jack butted on a long clamp, consisting of 6 x 6-in. timbers bolted together by three cross-pieces, the far end of the long clamp resting against a collar fitting snugly around the bell of the length of pipe remaining fast.

Two Knowles pumps, weighing about five tons apiece, were lifted from a well 24 ft. in diameter and 115 ft. deep, by means of two crabs and a ⅞-in. cable, with a single and double block on the water end and a double and triple block on the steam end, which was compound. Four men to each crab lifted one pump from foundation to surface in 42 minutes.

Two 3½ x 16-ft. boilers and 35 hydrants were also included in the job, besides which there was a steel tank 20 ft. in diameter and 32 ft. high, resting on a tower 80 ft. high. The taking down of the tank and tower was sublet to Mr. W. R. Tucker, of Hutchinson, Kan., who did a good job.

The contract provided for placing the whole water-works plant on the cars at Greensburg on or before March 1. Work was begun on Jan. 8 and completed on Feb. 14. The pumps, boilers, mains, hydrants, tower and tank made 21 car loads.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Reported for Engineering News by Andrews & Murdoch, Berrien Springs, Mich.

Use of Streets.

It is the settled law in Illinois that the construction of an electric railway on a street or highway imposes no additional servitude whether the fee in the street or highway is in the municipality or in the abutting owner; and, where the right to construct such road is granted by the public authorities, an owner of abutting property has no standing in a court of equity to enjoin the same. Rankin vs. St. Louis & B. Suburban Ry. Co., 98 Fed. Rep. (U. S.), 479.

Removal of Street Railroad Tracks.

The owner of a street railroad cannot maintain an action for damages against the municipality for its removal of the tracks from the streets with as little damage to the property removed as possible, where the ordinance granting the franchise reserved the right to make such removal in case the grantee failed to comply with certain conditions, and it has been conclusively adjudged between the parties that he did not comply with such conditions.

Stewart vs. Village of Ashtabula, 98 Fed. Rep. (U. S.), 516.

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ADVERTISING RATES: 20 cents a line. Want notices, special rates, see page XXI. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.

The Boston office of the Engineering News Publishing Co. has been moved, and is now located at No. 170 Summer St., Room 404. This location is on Dewey Square, adjacent to the new Southern Terminal Station.

"The Journal of the Association of Engineering Societies" for January contains the annual reports of the Board of Managers and of the Secretary of the Association, which show a most gratifying condition of prosperity. As some of our readers may remember, the organization of this federation of local engineering societies, which took place near 20 years ago, was largely due to the late A. M. Wellington, at that time a member of the Engineers' Club of Cleveland. It occurred to Mr. Wellington that the several engineers' clubs in the different parts of the country, by co-operating with each other, could arrange for printing and thus bringing before the profession the papers read at their meetings. Co-operation in other matters was also mooted; but it was left for the future to determine whether or not it was practicable, and the great growth of the national societies has discouraged development in this direction.

Four societies joined at the outset; those at Cleveland, Boston, St. Louis and Chicago; and the number was soon increased by the addition of other local societies. The present membership includes, besides the three first-named societies, those at St. Paul, Minneapolis, Kansas City, Detroit, Buffalo, New Orleans, Cincinnati, Helena and San Francisco. The total membership of the Associated Societies is 1,475. During 1899 the "Journal" contained a total of 958 pages, and the net cost of the journal per member amounted to only 78 cts., the revenue from advertisements, subscriptions and sales paying a large part of the cost of publication. The Association is furthermore in excellent financial condition, closing the last year with all bills paid and a balance of nearly $2,500 in its treasury.

We think it quite safe to say that no other engineering society makes so large a return to its members in the shape of technical literature for so small an expense as this federation of local engineering societies. The benefit to the societies is twofold. They are able to obtain a better class of papers than would be at all possible if the authors preparing them had no assurance of a wider publicity than that of their own local society; and at the same time each member secures, at a trifling cost, copies of all the papers read before eleven of the principal local engineering societies in different parts of the country.

For the present prosperity of the Association much credit is due to the officers who have had charge of its affairs, and especially its efficient secretary, Mr. Jno. C. Trautwine, Jr., on whom the chief burdens of executive management have fallen for the past four or five years. Such work especially deserves public recognition because it is done with little or no direct compensation, as a contribution for the benefit of the profession.

The prosperity of the Association also reflects the condition of the societies which compose it. We are glad to see that these local associations of engineers are not being wholly outclassed in the rapid growth of the national societies, and of the organizations devoted to particular fields of engineering work. The frequent meetings and the personal acquaintances which the local engineers' club affords, together with the fact that it brings together engineers engaged in a great variety of engineering work, furnish ample reasons for its continued existence.

To facilitate the construction of sewage purification works for Saratoga Springs by cutting down the waste of water along the lines noted editorially in our issue of March 1, a bill has been introduced in the New York Legislature providing for a board of sewer and water commissioners in place of the separate water and sewer boards now in existence. The bill authorizes the raising of water revenues by the meter system or assessments for benefits, or a combination of the two plans, and also authorizes the immediate borrowing of $20,000 in anticipation of taxes, which would make possible the speedy extension of the meter system. The bill provides that the meters shall be owned by the village, which is eminently proper, and that they shall be rented to the consumer, which is a questionable limitation. It would seem wiser to allow the commissioners to furnish meters with or without rental, as it sees fit, instead of having to go to the legislature for permission to furnish meters rental free, should future events prove that plan to be desirable. Whatever may be thought of the details of the bill its main objects are good: The removal of obstacles to sewage purification, the reduction of water waste and the simplification of municipal government by consolidating in one two departments naturally having much in common, but readily capable of inharmonious action on important questions of public policy.

SUBWAYS FOR STREET PIPES AND WIRES.

The old question of providing subways for the vast system of pipes and wires beneath the streets of New York has been raised anew, now that work on the underground Rapid Transit railway is to be started. The advantages of subways could easily be made obvious to the humblest citizen who walks the streets of New York and notes the frequency with which expensive pavements are dug up, the carelessness with which they are replaced, the rapid deterioration of the pavement that ensues, and the difficulty, and finally the impossibility of keeping such pavements clean. It is no exaggeration to say that the gross expense to the city treasury, to the private corporations directly concerned in these excavations, and to citizens generally, through the hampering of trade and traffic, amounts annually to millions of dollars. If capitalized, the aggregate of the items would reach an enormous total which might be devoted, with economy, to a subway system making the greater part of these disturbances entirely unnecessary.

The two greatest obstacles to a subway system, even if restricted to those sections where the demand for it seems imperative, are the difficulty of raising the funds for its construction, in view of its large first cost, and the many other pressing demands on the city's credit, and, second, the opposition of many of the great corporations occupying the streets. It is true that rentals for the use of the subway system might easily put it on a revenue-producing basis from the start, but that would not obviate the necessity for increasing the bonded indebtedness of the city, and the prospect of having to contribute these rentals constitutes one of the principal grounds of objection on the part of the corporations in question. Not all the corporations would oppose a subway system, either on this or any other ground, for, properly presented, its benefits to them would be so great and so obvious as to overcome much opposition.

In this country, municipal growth has been so very rapid that the streets of our largest cities became filled from side to side, and from the surface to great depths below, with a heterogeneous collection of pipes and wires before the need for a subway system was realized. A number of cities, to escape from the dangers and unsightliness of overhead wires and poles, have placed their various electrical wires underground, and have termed the results, in some cases, electrical subways. Underground electrical conduits is a better term, there being no sub way (underground passage) in this class of work, although, fortunately, the nature of the wires is such as to enable a large proportion of the repairs, renewals and additions to be made at manholes, without disturbing the pavements proper.

The nearest approach to subways, in the broader sense of the word, in any city in the United States is found at St. Paul, Minn., where the city has taken advantage of a soft sandstone formation to build tunnels for sewers and water pipes. Telephone cables have also been placed in tunnels by a private company in St. Paul. The tunnels for each service are entirely separate, but they are none the less subways, as they give access to the pipes and wires without digging up the streets, the house connections, or some of them, also being made through branch tunnels. Some of the water meters are placed at the junction of services and street mains, and as the tunnels may be reached through a trap-door in one of the city buildings, they have many points of convenience.*

Foreign examples of municipal subways may be cited as existing at London, Nottingham and St. Helens, England, at Paris and at Milan. The subways at Milan are described thus by Dr. Albert Shaw†:

> The Via Dante was constructed as the direct approach from the heart of the city to the curved front of the symmetrical new park. It is paved with wooden blocks on a concrete foundation, is lighted with electricity, and is traversed by an electric street railway. But it is more notable for its underground construction than for its beautifully executed surface; for, apart from the main sewers, there are subways on either side of the street, 6 ft. high by 4 or 5 ft. wide. These subways adjoin the front foundation wall of the houses, and make it easy to inspect and repair the drain pipes that connect the houses with the sewers. Within the subways are placed the water pipes, gas pipes, electric wires, etc., and passages extend from them to the main sewers. It is considered in Milan that no street elsewhere in Europe so completely embodies the best principles of construction—below the surface if not above—as the new Via Dante.

The manner in which the great sewers of Paris are utilized as subways for various other branches of municipal service is so well known as hardly to need description, but it is not so well known how this combination aids in keeping in a cleanly and generally perfect condition the famous streets of Paris. On this point we cannot do better than quote from a former editorial,‡ as follows:

> The almost perfect condition of the Paris streets is intimately connected with the fact that the disturbance of this street surface by pipe trenches is practically eliminated. Water and gas pipes, telegraph and telephone wires, pipes for compressed and for hot air, and the entire tangle of fixtures and appliances buried under the streets of other cities are here disposed of in roomy, well-ventilated and well-lighted subways. Aside from the fact that this disposition does away with cutting into

*See "The Sand Rock Sewers of St. Paul, Minn.," by Geo. L. Wilson, Trans. Am. Soc. C. E., August, 1894, and abstracted briefly in Eng. News for June 28, 1894; also description of personal inspection of sewer and water tunnels in "Notes in Four Western Cities" (Editorial Correspondence), Eng. News, March 19, 1896.

†"Municipal Government in Continental Europe," pp. 260-1.

‡"Paris Sewers and Subways," Eng. News, Aug. 22, 1895; sections of some of the sewers are given in the same issue in an article on "The Sewerage System and Sewage Farms of Paris."

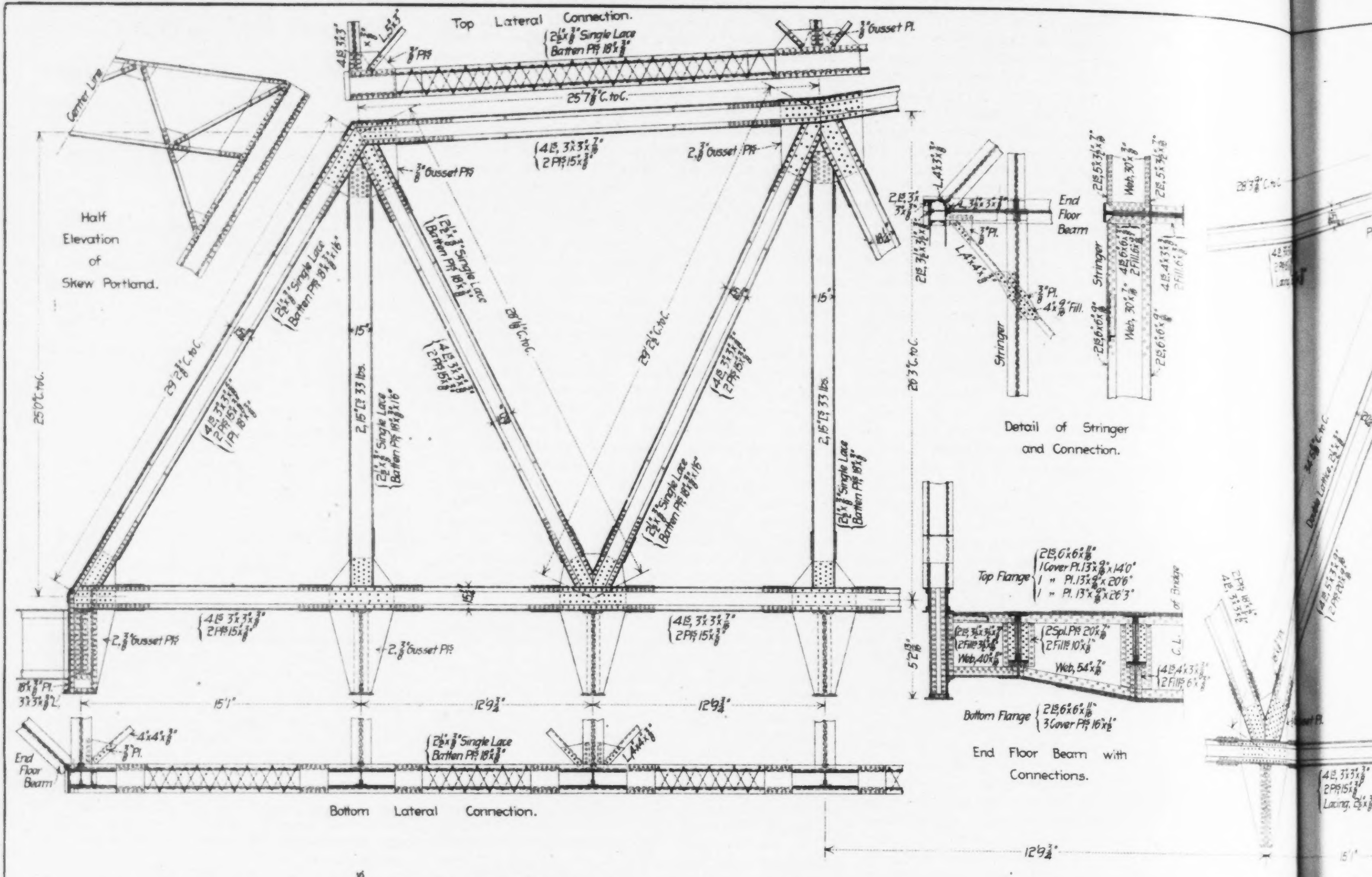


FIG. 2. DETAILS OF TRUSS "B

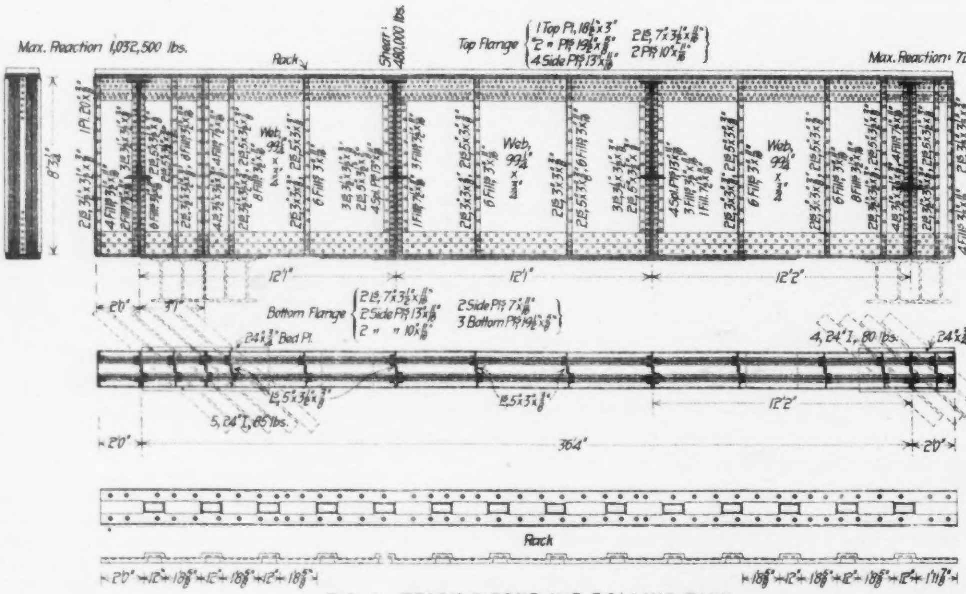


FIG. 6. TRACK GIRDER AND ROLLING RACK.

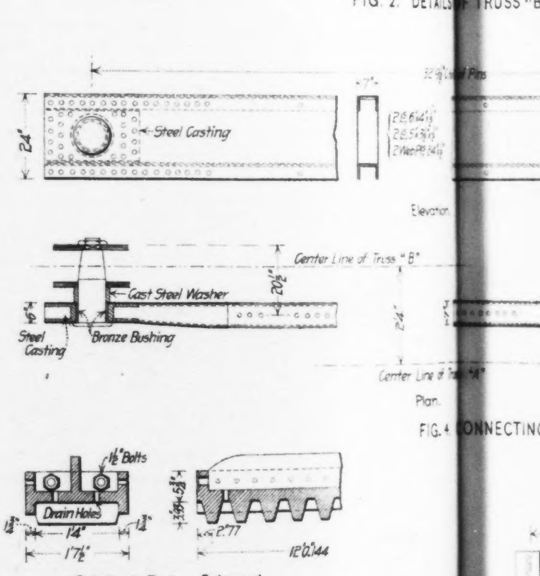


FIG. 4 CONNECTING

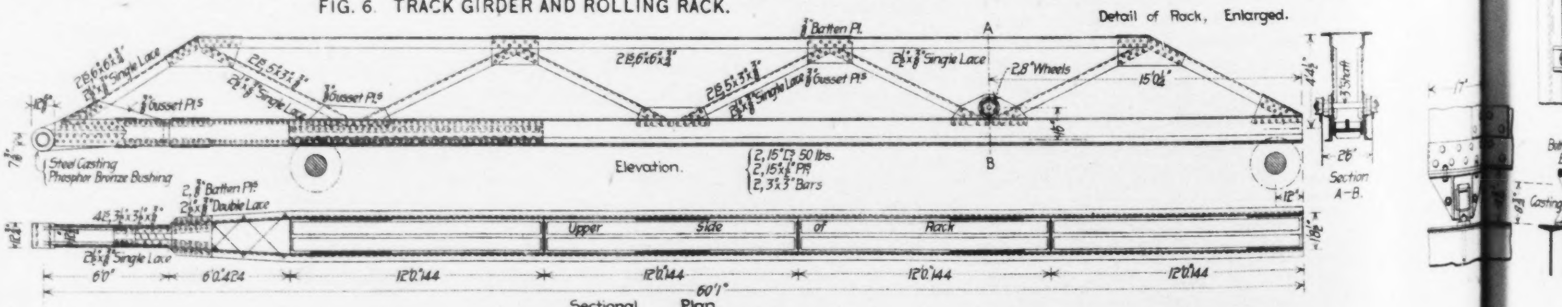
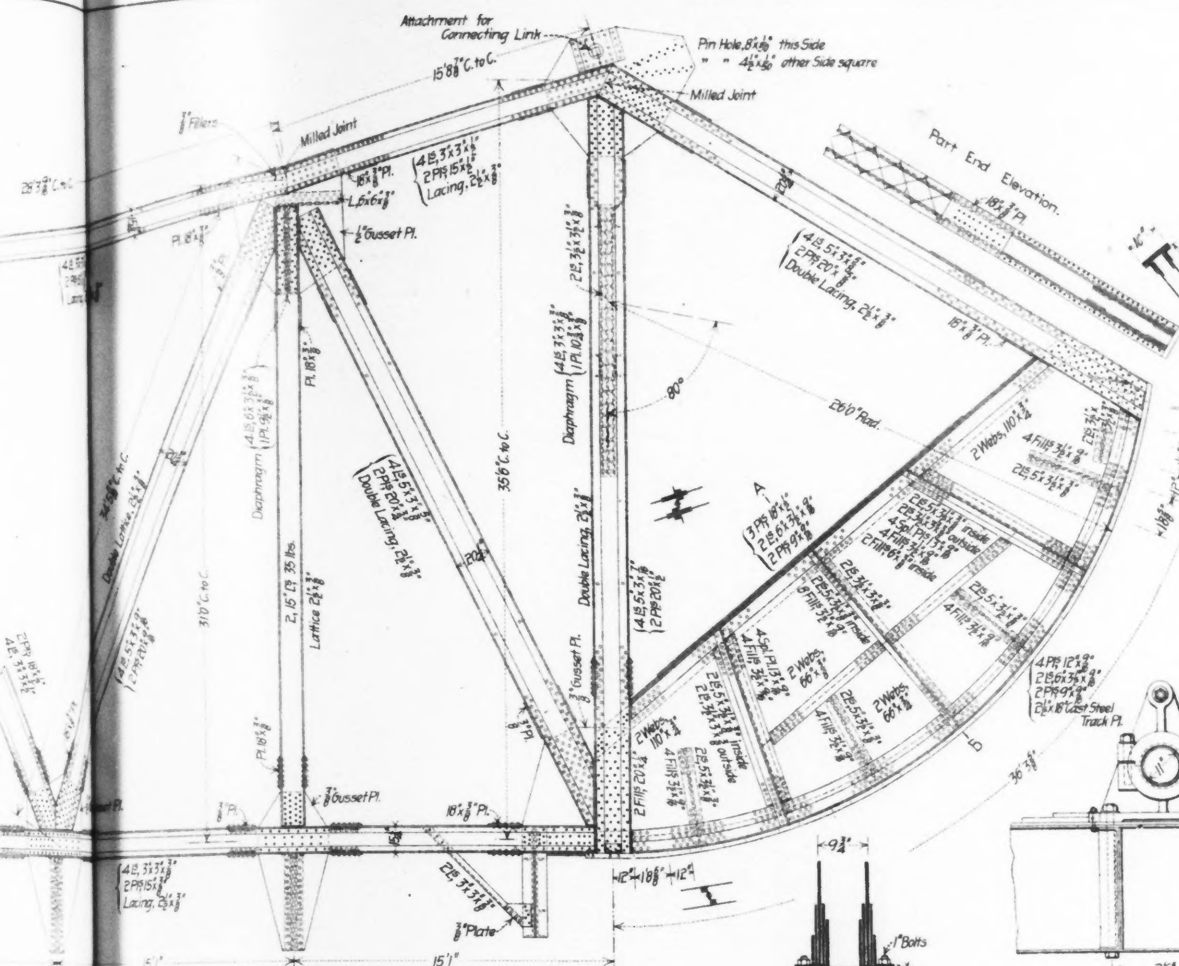


FIG. 8. OPERATING STRUT.

SIX-TRACK ROLLING-LIFT DRAWBRIDGE OVER FORT POINT CHANNEL, BOSTON, MASS. FOR

F. S. Curtis, M. Am., Soc. C. E., Chief Engineer; N. Y., N. H. & H. ... Sch



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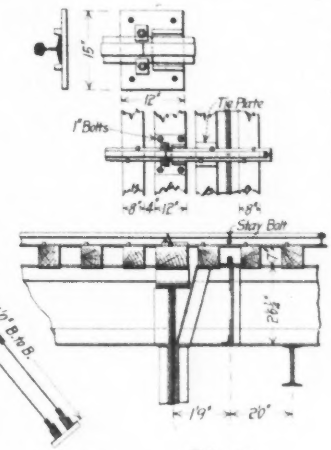


FIG. 12. END RAIL JOINT.

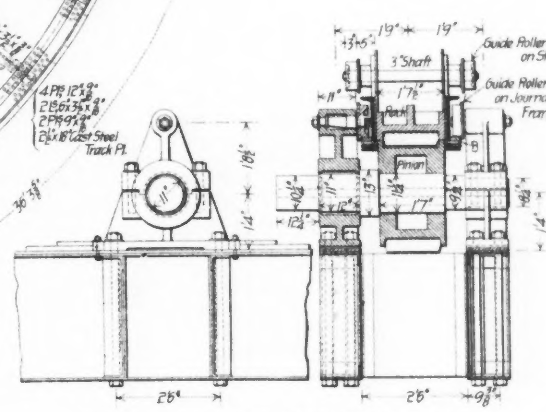
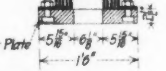


FIG. 9. OPERATING RACK AND PINION



Section of Base of Rolling Segment Enlarged.

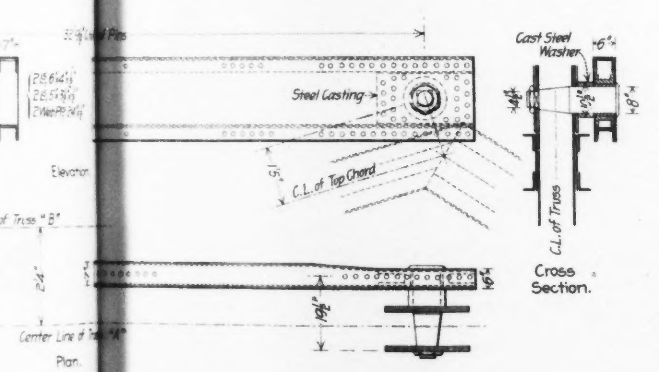
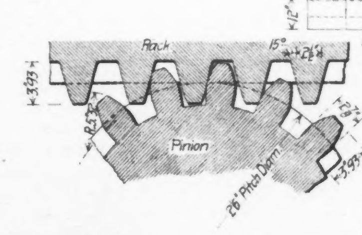


FIG. 4. CONNECTING LINK.



Rack and Pinion, Enlarged.

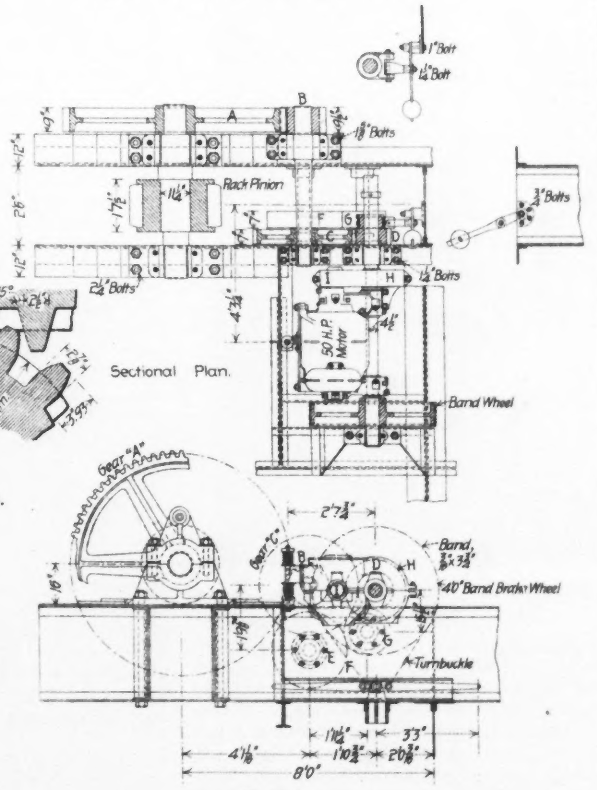


FIG. 10. OPERATING MACHINERY.

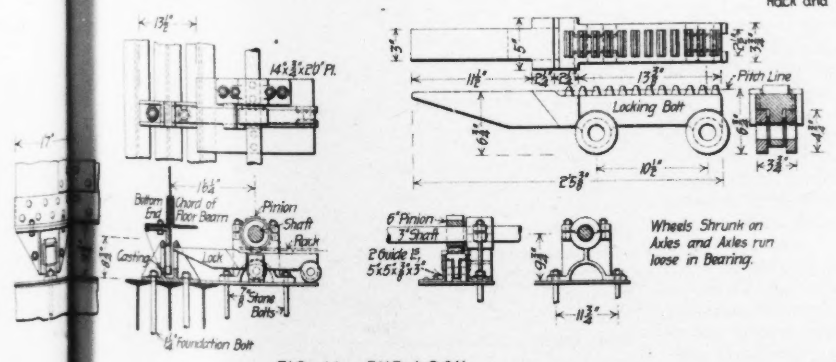


FIG. 11. END LOCK.

OSTON, MASS. FOR THE BOSTON TERMINAL CO. (NEW YORK, NEW HAVEN & HARTFORD R. R.)

Scherzer Rolling-Lift Bridge Co. & Pennsylvania Steel Co. Contractors.

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

and replacing pavements, and prevents the obstruction of the streets by poles and overhead wires, there are other economic advantages.

Pipes buried in the ground are usually left to take care of themselves until some radical and apparent defect or leakage makes repairs imperative, not only on the pipes, but on the streets as well. In the Paris subways the pipes are always accessible; they can be kept in thorough repair and will consequently last longer; the smallest leak is at once detected and checked, and waste is prevented. Finally, when a new and better system is devised for any purpose, old fixtures can be removed and new ones put in with a minimum of expense, as compared with the methods elsewhere. In New York, under many streets, old unused lines of gas and other pipes are rusting slowly away, interfering with street excavations and causing settlements as they collapse, simply because it will not pay to dig them up. With a subway system this would be impossible.

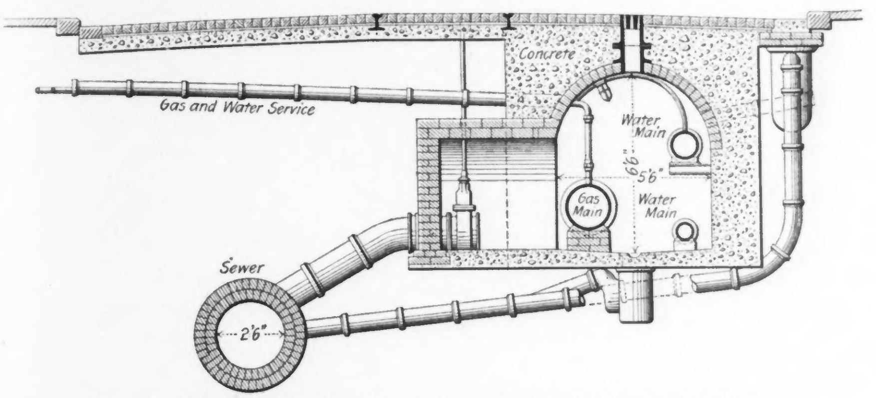


FIG. 1.—SECTION THROUGH SUBWAY AT ST. HELENS, ENGLAND.
Geo. J. C. Broom, M. Inst. C. E., Borough Engineer.

The London subways date from 1861, when a new street was opened from Covent Garden Market to St. Martin's Lane, having a central arched passageway beneath it, 12 ft. wide and 6½ ft. high, with branches for the various house connections from the water, gas and telegraph mains. At present there are subways in Queen Victoria St., Victoria Embankment, Northumberland Ave., Shaftsbury Ave., Charing Cross Road, Southwark St. and Rosebery Ave. These subways vary in size from 14 × 7½ ft. to 8 × 7 ft. The walls are of brick in cement, covered with a semicircular brick arch, and ventilated to the street each 100 ft. of their length. Gas, water, electric light, hydraulic supply, telephone and telegraph mains, are laid in these subways.*

Almost coincident in time with the first London subway one was built at Nottingham, England, in 1861-2, in Victoria and Queen Sts., and a little afterwards in three other streets. In 1886, and again in 1892, others were added. In the latter year Mr. A. Brown, Borough Engineer of Nottingham, spoke of the first subway as follows (the capitals are ours)†:

To show the value of such works, in the street called Victoria St., in which is situated the General Post Office, there are besides the gas and water pipes and connections no less than six pipes containing telegraph wires in this subway AND NOT ONE SINGLE STONE WAS DISTURBED IN THIS CARRIAGEWAY FOR 25 YEARS, AND IN THAT PERIOD NOT ONE SINGLE PENNY WAS SPENT ON (PAVEMENT) REPAIRS IN THIS STREET.

The subway which Mr. Brown was building in 1892 was connected with a class of municipal improvements quite common in England, but rarely undertaken here, the regeneration of an unhealthy and condemned area of 12,500 sq. yds., which "was covered with a wretched and disreputable class of property, and was very much overcrowded." The land was purchased and developed under the "Artisans' and Laborers' Dwelling Act, 1875." The subway is 10 ft. wide by 8½ ft. high, covered with a semicircular brick arch, and ventilated to the street every 48 ft., and also through various side entrances. Besides the subway, vaults 8½ × 9¼ ft. in plan, and about 7 ft. high are built on each side of the street and rented to abutting property-holders. The vaults are connected with the subway by side-connections, about 40 ft. c. to c., 4 ft. high and 3 ft. wide. The floor of the subway is of concrete brought to a smooth surface, and the side-connections and vaults have brick floors. Provision is made in the subway and side-connections for all the necessary pipes and wires. Hydrant and valve chambers are located in some of the side-connections. The advantages of the system are summed up by Mr. Brown as follows:

By this method of construction access can be obtained to and any alterations and additions made to sewers, gas, water and other pipes, and the house connections therewith; the fire hydrants and valves can be examined, repaired and renewed, without taking up or disturbing one single stone in the surface of the street. The life of the iron pipes and connections in the subway is practically everlasting, as there is no rust, and the expense of relaying mains and especially gas services through this course is saved.

As to dangers from freezing, Mr. Brown stated that with a temperature in the open air of 19° in the city, and 13° at Nottingham Castle, outside the city, the subway showed a temperature of 41°. The subways and vaults are rented at 5 per cent., against 3½ per cent. interest paid on the loan account. In conclusion Mr. Brown urged that

in the case of new main streets and where main thoroughfares are improved and widened, the opportunity should be seized to lay down subways in order to minimize as much as possible the evils resulting from the continual taking up and relaying of streets.

The principle thus laid down has been followed quite recently at St. Helens, a most progressive English county borough, with a population of about 90,000. The borough owns gas, water, sewerage, sewage and garbage disposal systems, a public slaughter-house, market, baths, library, hospital and cemetery. Quite recently it bought the street railway system from a private company and transformed it to an electrical system. As the whole of the street surface of the main business thoroughfare had to be torn up to build a new sewer, renew the gas and water mains and services, and lay electric cables, the question of putting in a subway was raised and referred to the borough, water and gas engineers. On receiving a favorable report from these three officials, it was decided to build a subway in Ormskirk, Church and Raven Sts. Plans for the work were made by Mr. Geo. J. C. Broom, M. Inst. C. E., Borough Engineer, and the work was carried out under his direction.* The subway was opened on April 28, 1899. It is 5½ ft. wide by 6½ ft. high and 2,040 ft. long. It is built wholly of concrete, as shown in the section, Fig. 1, except for an arch ring of blue brick, 4½ ins. thick. Open gratings, 100 ft. apart, ventilate the subway at each end. Midway in its length there is an entrance to the subway through the sidewalk, 9 × 14 ft. in plan, covered with eight Hayward prism lights. Trapped drains connected with the sewer are provided at intervals, and there is an emergency valve for use in case a water main should burst. Incandescent lamps, 28 ft. apart, are provided for lighting the subway, with such precautions that the lights may be used without fear of an explosion in case of gas leakage.

The completed subway, with pipes in place, is shown by the view, Fig. 2. The extent of this use, thus far, and the cost of the work, are given by Mr. Broom as follows:

The subway at present contains one gas main, 18 ins. in diameter, and two water mains, one 10 ins. and the other 6 ins. in diameter. The services for both gas and water are passed through 6-in. earthenware pipes beneath the roadway where necessary, to the underside of the curb on either side of the road. Due provision has also been made for carrying the telephone and electric light cables and these will shortly be laid. The work of constructing the subway, together with the laying of the gas and water mains and tram-lines, and paving the street, was carried on simultaneously. The cost of the work has been £7 2s. 4d. per lin. yd. ($11.55 per ft.); this amount includes all the lateral ways and the electric lighting throughout.

The foregoing review of subways already built, together with the incidental comments and suggestions, scarcely needs to be supplemented with further remarks as to the general advantages of subways in American cities.

In New York city, however, there is a peculiar and unprecedented opportunity to undertake the work of subway construction at the present time. In building the Rapid Transit railway, there will necessarily be a more or less complete disturbance and relaying of the pipes and wires now in the street. Such was the experience in Boston and such it will be here. An additional expense, small in itself, and insignificant in comparison with the resulting gains, would enclose the disturbed pipes in galleries where they would be accessible at all times without damage to the streets and without the expense attendant on street excavations. Of course, the length of possible subways in connection with the present rapid transit scheme is small in comparison with the total street mileage in which subways might be placed to advantage, but with so good a beginning, the subway system would be found so beneficial that its subsequent rapid extension would follow as a matter of course. The value of a subway system in reducing the leakage from water and gas mains is by itself a matter of great importance. Leaks in gas and water mains could be repaired so easily in the subways that all leakage in those sections might be stopped, at the same time calling attention to the great leakage constantly in progress in the mains outside the subway systems.

Whereabouts in the streets subways might best be placed is a question to be answered only after full knowledge of all the governing conditions in

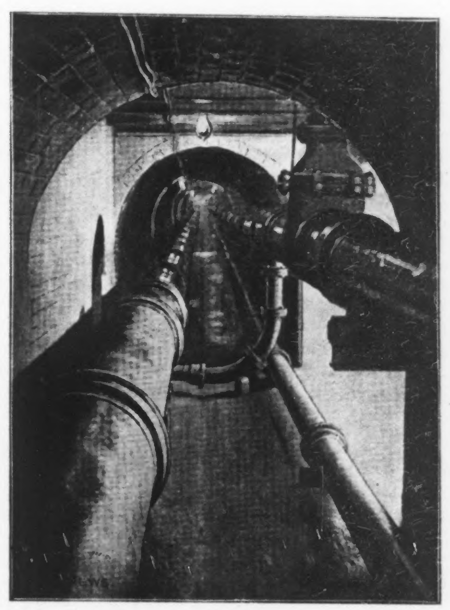


Fig. 2.—View of Subway in Use, St. Helens, England.

each street. In a recent interesting paper* on the general subject of subways, Mr. H. C. Hodgkins, of Syracuse, N. Y., urged very strongly that there should be a subway beneath each sidewalk, with main sewers in the center of the street. Where the space under the sidewalks is already occupied with private vaults, as is often the case in New York, this might involve some difficulty.

Probably the greatest obstacle to securing subways alongside or over the New York rapid transit system will be the legal complications which might

*For these figures we are indebted to Mr. Broom's account of the subway at St. Helens, mentioned further on.

†From a paper by Mr. Brown, read before the Assoc. of Municipal and County Engineers and abstracted in Eng. News, July 21, 1892.

*We are indebted to Mr. Broom for a pamphlet describing the subway and the ceremonies attendant on its opening, from which this description and our illustrations have been prepared.

*"The Economic Arrangement and Construction of Substructures in Streets," Proc. Am. W.-Wks. Assoc., 1899; abstracted briefly in Eng. News for May 25, 1899.

result if the project were undertaken at the present time. Unfortunately for the success of the scheme, the recommendations in its favor made away back in 1891 by Mr. W. B. Parsons, then Principal Assistant and now Chief Engineer to the Commission, were finally rejected; and the project has only been brought forward again within the past week, after the contract for the work has been awarded, and the time for adjournment of the legislature draws near. It appears doubtful whether the Rapid Transit Commission has authority to build subways on its own account, and very likely the city is in no better condition to carry out the work, since it generally has to appeal to the legislature for authority to do anything out of the ordinary routine. Whether or not legislation could be secured during the brief remainder of the present session enabling the city to build subways at the same time that the Rapid Transit work is done is a question for others to settle. It is gratifying, however, to note that the engineer to the commission has been instructed to make estimates of the cost of including subways for pipes and wires with the rapid transit work, for it will at least serve the good purpose of attracting attention to a class of improvements which is of the utmost importance to New York, and which bids fair to become an absolute necessity at some date in the near future.

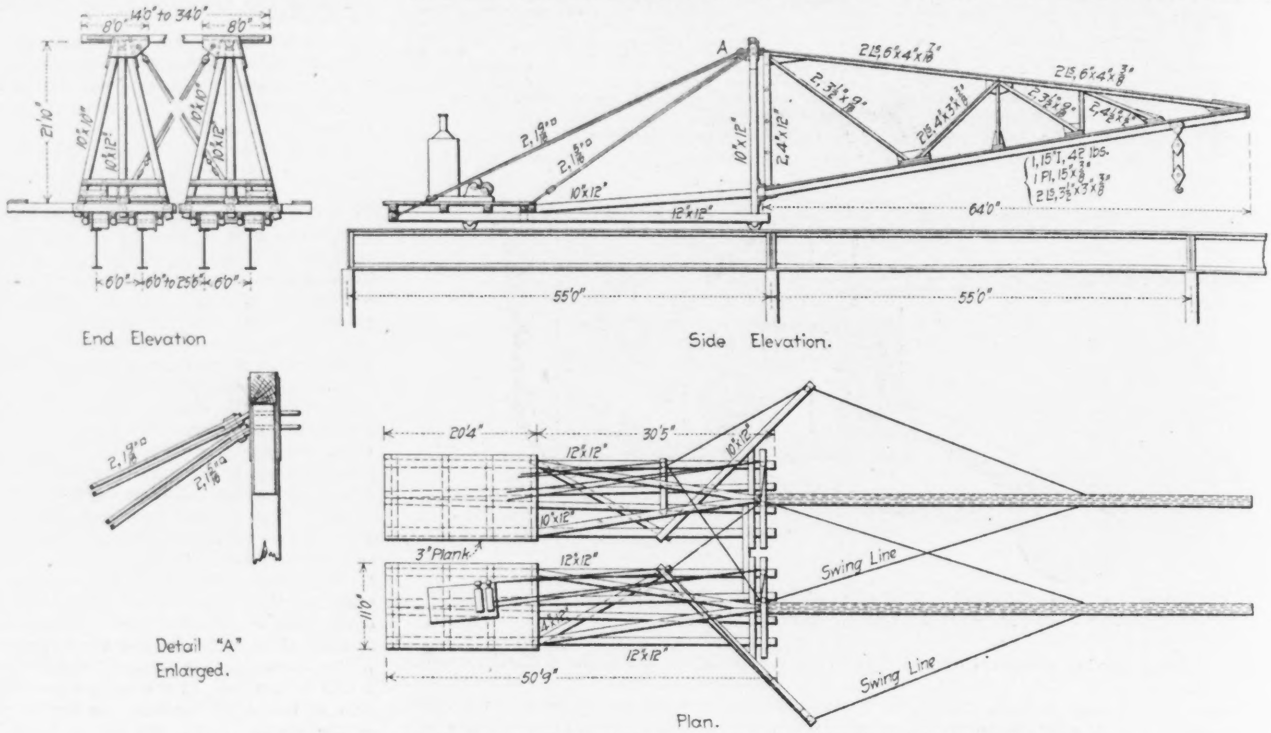


FIG. 1.—PLAN AND ELEVATIONS OF TRAVELER FOR ERECTING BOSTON ELEVATED RAILWAY.

LETTERS TO THE EDITOR.

Street Cleaning Statistics for Forty American Cities.—Correction.

Sir: In the issue of your journal of Feb. 22 you published a table of the cost of street cleaning of 40 principal cities and among them was this city. It is stated that the cost of street cleaning in this city in 1898 was $37,511, while the cost was really $69,406. The mileage of paved streets is correct; also approximate square yards of paving. Another error is the statement that the street cleaning in this city is done by contract; it is done under my direction and by department employees. The rest of your table is substantially correct, and I cannot understand who gave Mr. Rosewater the information for this city.

Yours truly,
J. C. Mundy,
Genl. Supt. of Works.

Newark, N. J., March 7, 1900.

(We improve this opportunity to state that the third column under unit costs should have read per 1,000 sq. yds., instead of "per sq. yd.," an error which crept in when we rearranged and combined in one table the two original tables which Mr. Rosewater kindly sent us. This error, quite naturally, is included in the photographic reproduction of our table by one of our contemporaries, without credit to this journal.—Ed.)

The Record Rainfall for the American Continent.

Sir: The readers of Engineering News are probably well aware of the reputation enjoyed by Greytown, Nicaragua, as a region of excessive rainfall. All previous records, however, have been broken by a downpour for the 22 hours ending 4 p. m. Nov. 4, 1899. In this period the rain gage of the Isthmian Canal Commission indicated a precipitation of 12.48 ins. On the same day a rain gage maintained by the Caribbean & Pacific Transit Co. at Lake Silico, about eight miles southwest of Greytown, indicated a precipitation of 13.05 ins., 10.5 ins. of which fell in the six hours from 9 a. m. to 3 p. m., an average during these hours of 1¾ ins. per hour.

The completion of the record at Greytown for 1899 places in our hands the measurements for five complete years, 1890, 1891, 1892, as kept by the Maritime Canal Co., and 1898-1899, as kept by the U. S. Commissions. The average for these five years is 258 ins.; the maximum year exceeds the minimum by about 95 ins.

So far as known the rainfall at Bluefields, on the same coast, about 75 miles northward, does not reach a quantity nearly as great as that of Greytown. This is also true of Port Limon, about the same distance southward, on the same coast. The rainfall also decreases rapidly as we pass westward from Greytown.

So far as I am aware these records show for the vicinity of Greytown the greatest precipitation for one day, the greatest for a period of six hours, and the

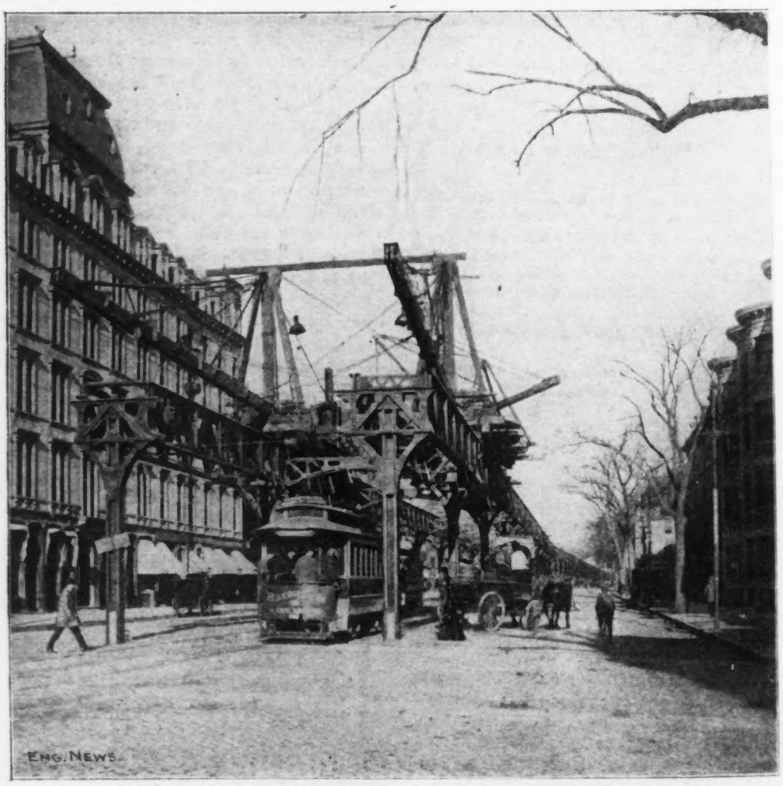


FIG. 2.—VIEW SHOWING ERECTION IN PROGRESS ON WASHINGTON ST., LOOKING NORTH FROM NEWTON ST.

greatest annual mean ever measured on the American continent.

If you or any of your readers know of records to exceed these I should be glad to learn of them.

Yours very truly A. P. Davis,
Hydrographer, Isthmian Canal Commission,
Greytown, Nicaragua, Feb. 26, 1900.

railway construction? Does the timber endanger the work if left some feet below the ties?

We know of no trouble experienced from the cause stated. Timber buried deeply in embankments in a railway fill is so thoroughly excluded from the air that its decay is probably exceedingly slow. The only effect when the decay occurs will be the gradual settlement of the embankment in the course of years, which will be taken care of by the track repair forces like any other settlement. If any of our readers have experience to the contrary, we shall be glad to hear from them.

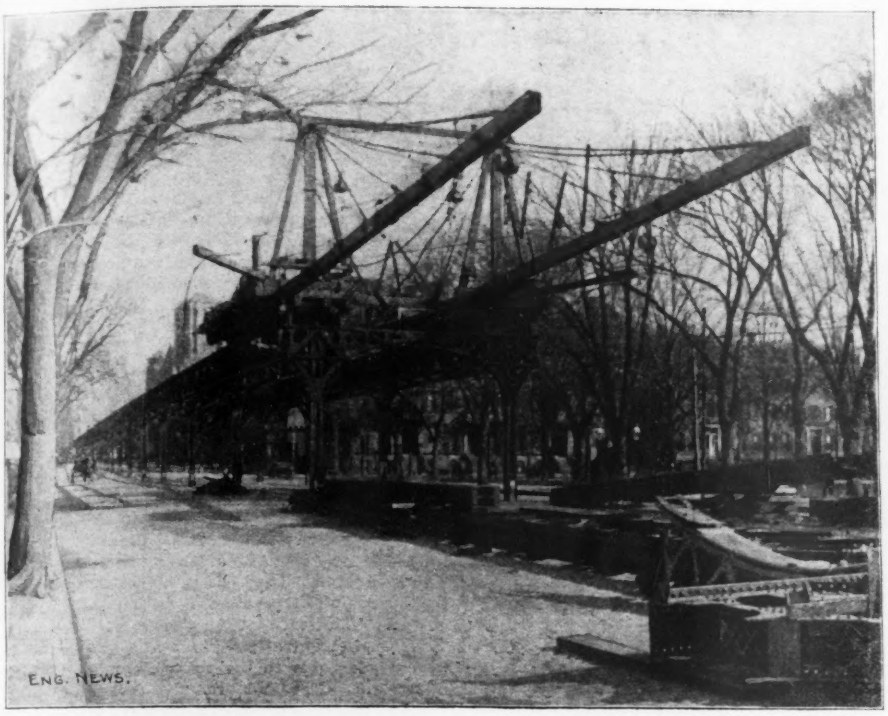


FIG. 3.—VIEW SHOWING ERECTION IN PROGRESS ON WASHINGTON ST., NEAR WORCESTER ST.

The Silting-Up of Lake McDonald and Leaks at the Austin Dam.

Sir: In your issue of Feb. 22, you published an article from Prof. T. U. Taylor, of the State University here, on the silting-up of Lake McDonald and the leak in the Austin Dam. You also commented on the article and seemed to desire more information.

Had our Mayor, Mr. Jno. McDonald, not interfered with the supervising engineer's original plans, and called in a consulting engineer who supposed he had to make a change or he would not have been looked upon as a greater man, Austin would not have the leaks under the bulkheads to-day.

I contend that changing the original plans from a canal system to the headgate masonry and penstocks, as they are now, is the sole cause of all our trouble. Mr. Frizell, the engineer who had made thorough investigations and soundings, certainly knew that the character of the soil or rock in the banks would not permit a disturbance by excavations for a foundation, and therefore recommended the canal system. The local interference by self-constituted experts, caused Mr. Frizell to resign a $5,000 position, as his reputation as an engineer was at stake.

In reference to whether nature itself is against municipal ownership of this magnificent water and light plant, I wish to direct your kind attention to five copies of our "Evening News," which I mailed you to-day, bearing dates Feb. 21, 23, 24, 27, and March 1. In the copy of February 21, you will find a very interesting report from the engineer who was sent here by the syndicate that holds the Austin Water & Light bonds, Mr. Babson. From the other copies of the "Evening News" you will no doubt observe that the conditions which existed in Philadelphia at the time they wanted to rob that city of its water plant are repeating themselves here.

The majority of the very best citizens and taxpayers are strongly in favor of the city paying the interest due on the bonds, but there is a faction here that controls the majority of the council, and that body has refused to make the appropriation to pay the interest, although $70,000 is now in the city treasury for that purpose.

A bare majority of the council (constituted by four aldermen who pay scarcely any tax) and a few others who are interested in the old Water Co., are exerting themselves to injure the credit and reputation of the city against the will of a large majority of the best citizens and heavy taxpayers. Yours truly,

P. H. Gerhard.

Austin, Tex., March 8, 1900.

Notes and Queries.

J. W. S., Anderson, Ind., writes:

What is the advantage or disadvantage from leaving piling and trestling timbers in earth embankments for

THE ERECTION OF THE BOSTON ELEVATED RAILWAY.

By Charles Evan Fowler, M. Am. Soc. C. E.*

The erection of the steelwork of the Boston Elevated railway, the design of which was fully de-

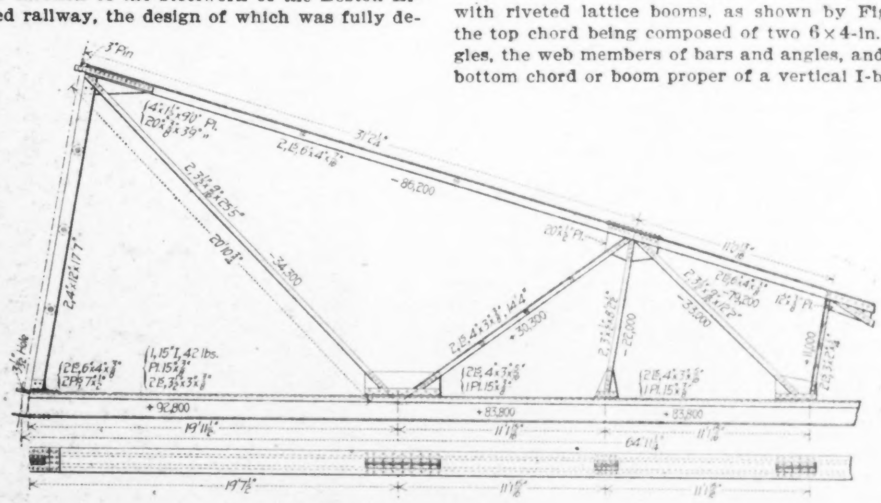
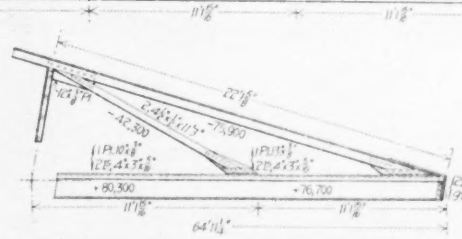


FIG. 4.—DETAILS OF STEEL BOOM FOR TRAVELER FOR ERECTING BOSTON ELEVATED RAILWAY.



scribed in Engineering News of May 11, 1899, was sublet by the Pencoyd Iron Works, of Pencoyd, Pa., the contractors for its manufacture, to the Terry & Tench Construction Co., 11 Broadway, New York city. Work was begun by the subcontractors on Aug 19, 1899, and up to the present time about 200 spans, aggregating some two miles of line, have been put in place on the Roxbury Division.

The necessity for keeping the street clear, made it imperative that the traveler be an overhead one running upon the completed structure, and carrying the hoisting engines and other apparatus.

There are in effect two 10-ton travelers, one on each pair of main track girders, but connected together so as to be readily adjusted to the varying width of the tracks, as shown by Fig. 1, Figs. 2 and 3 are views of the traveler in operation. The main sills in each half consist of four 12 x 12-in. timbers, planked over for a length of 20 ft. 4 ins. at the rear end to carry an engine. From the front of this platform brace timbers are run to the foot of the main 10 x 16-in. post, which is braced by two 10 x 12-in. batters. The head block is made up of large plate and angle iron construction, which connects to the cap across from one side to the other, and through which pass the links for connecting the back stays and the booms. Under the sills are cast-iron rollers with 18-in. faces, which allow of a slight variation in the center distance between tracks, but the greater variation must be taken care of by the sliding cap and the sliding cross sill, which allow for a change of 20 ft. The transverse sway bracing consists of two sets of falls crossing, as shown by Fig. 1. The back stays of the traveler now in use are two 1⅝-in. steel wire ropes, as are the guys of the boom, which is of two channels tied together across the top flanges, with the hoisting trolley running inside on the bottom flanges. The trolley is run backward and forward along the boom by ¾-in. wire rope running to the engine. The hoisting rope is ¾-in., while ⅝-in. ropes run to the engines for swinging the booms.

These engines were constructed by the Lidgerwood Mfg. Co., especially for this work. They have double 7 x 10-in. cylinders, double drums and two spools, one on each drum shaft. Just inside the spools are narrow drums on which are wound the lines for swinging the booms, and which are operated independent of the main drums and spools.

The work on the other divisions will require another traveler, and this is now being constructed with riveted lattice booms, as shown by Fig. 4, the top chord being composed of two 6 x 4-in. angles, the web members of bars and angles, and the bottom chord or boom proper of a vertical I-beam with a top flange of a 15-in. plate and two angles, the calculations assuming that the boom would be stayed sidewise by the swing lines and by tag lines. The hoisting trolley in this case will run on the bottom flange of the beam.

*Consulting Engineer to the Terry & Tench Construction Co., 11 Broadway, New York City.

The crowded condition of the streets during the day, together with the fact that the electric surface lines demanded the use of the streets beneath the structure, made it necessary to do the erection at night, work being commenced at 9 p. m., and continued until 5 a. m. When the material is on hand in sufficient amounts, to have it strung out along the line of the work, by the specially designed 20-ton swing trucks, from six to twelve spans can be erected each night.

Electric arc lights were found to be too expensive and two Washington incandescent lights were hung on the traveler, producing a much steadier and altogether more satisfactory light than electricity. The lamps have a mantle similar to a Welsbach gas lamp, but use gas from gasoline, $1\frac{1}{4}$ gallons being used by each lamp in one night.

The first two spans were put in place with ginpoles, then the traveler put in place on top and the erection carried on continuously. The structure, as can be seen in Fig. 5, leaves the street much more open and unobstructed than does the usual elevated railway, and the cross struts being arched present a handsome appearance as well. The foundations are below street grade entirely and the columns are made from specially rolled shapes with rounded corners, thus allowing abundance of wheel room and nothing to catch the hubs.

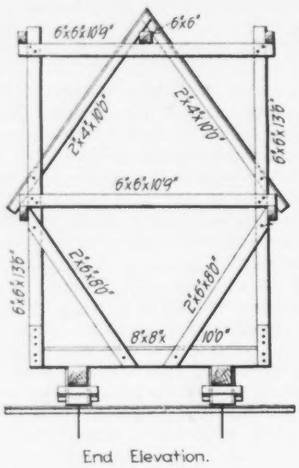
The riveting is being mostly done by compressed air, the long gun type of Boyer riveters being used. This machine has a weight of 18 lbs., and delivers 800 strokes per minute, the stroke being 9 ins. Yoke percussion riveters were originally used, but owing to the cramped condition of many of the rivets, they did not prove a success; owing to this same condition it has not been possible to drive more than 280 to 300 rivets per day, with two men at a machine and a heater at the forge. This has been exceeded by hand gangs, who can get at the rivets more quickly, the record reaching nearly 400 rivets per day.

Percussion riveters have been used on the Northwestern Elevated at Chicago, driving as high as 500 rivets per day, but with three men at a riveter and the heater. Hand gangs on that work have averaged only about 300 rivets per day.

The greatest record known to the writer was that reported on a 70-ft. three-track railway girder span, where a maximum of 900 rivets were driven in a day of nine hours. The reinforcing work that is under way on the Manhattan Elevated is being riveted with percussion machines, and the record runs from 465 to 525 rivets per day.

Careful tests were made of the amount of air used in driving rivets, the average in driving 25 rivets $\frac{3}{4}$-in. in diameter was 5 cu. ft. of free air per rivet.

The compressor plant is placed on what is termed a riveting traveler, which is a house, as shown in Figs. 6 and 7, 10 ft. by 16 ft., and about 14 ft. high, of simple construction, the sills carrying a floor on which to set the machines. The steep pitched roof is covered over with tarred paper, while under the sills are four timber trucks with iron rollers, so that the traveler is rolled along on the girders as the work progresses. The compressor is a Christensen Electric one (Eng. News, June 1, 1899), the motor forming part of the machine proper and driving, in the compressors now in use, three compressing cylinders with a capacity of 75 cu. ft. of free air per minute.



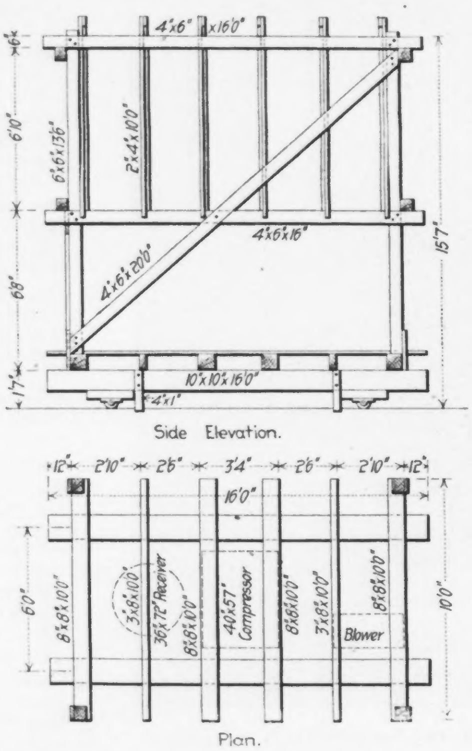


FIG. 6.—GENERAL DETAILS OF RIVETING TRAVELER FOR FIELD RIVETING; BOSTON ELEVATED RY.

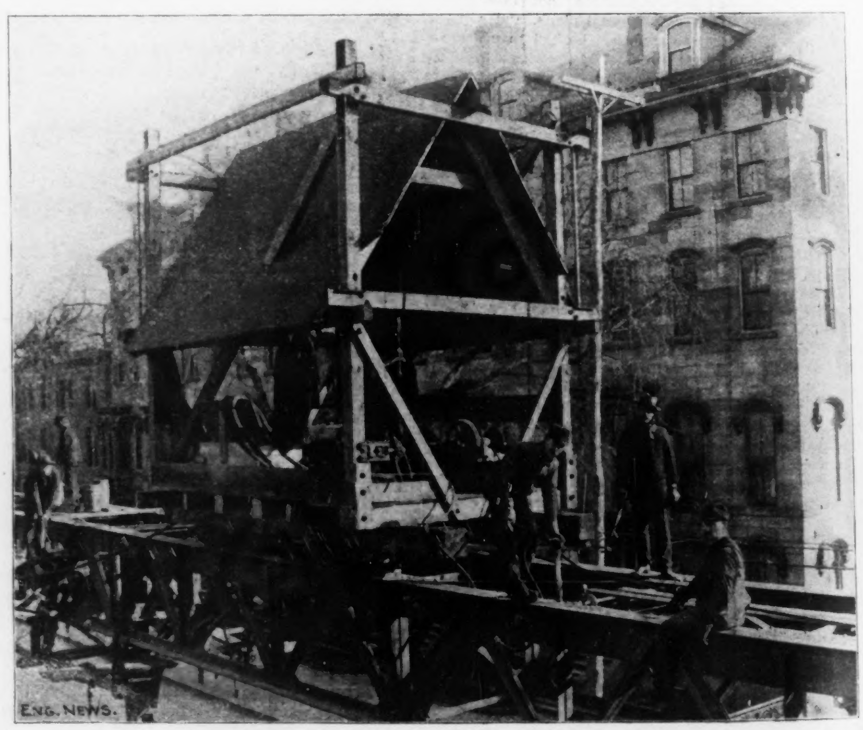


FIG. 7.—VIEW OF RIVETING TRAVELER IN OPERATION; BOSTON ELEVATED RY.

The machine for permanent work will have three cylinders, with a capacity of 155 cu. ft. of free air per minute. The compressor and motor complete only occupy a space of 40 × 56 ins., with a height of 40 ins. To maintain the pressure required, from 90 to 100 lbs. requires a 33-HP. motor, the current being derived from the trolley feed lines along the line of the elevated. The traveler also carries the receiver, which is 36 ins. in diameter by 72 ins. long, and space is provided for a fan blower, to blow the forges, the armature shaft being long enough for a pulley to drive it. The forges at present in use, which are hand blown, are the progressive, which have a fly wheel, so that the fan will keep on blowing for some time after the lever is stopped.

The new Charlestown bridge, which has been under construction for some time past, forms the link across the river, and the section north from this will be the next erected, reaching to Scollay Square. Then the link from the Roxbury Division to the subway will come next, after which the link from the Charlestown Bridge to the north end of the subway will be built, and lastly the Atlantic Ave. division which connects the north and south elevated systems.

The Terry & Tench Construction Co. is also erecting the Dudley Street Terminal for the Pennsylvania Steel Co. This is an extensive piece of work near the southern end of the Roxbury Division. An elevated siding leaves the main line of the elevated, passing through the center of the terminal house on the level of the second floor, which is about 19 ft. above the ground floor, and connecting again with the main line beyond. The station is 71 × 178 ft. in eleven panels, with the main roof over the central portion, and a wing on each side covering over to the electric car lines, which run up an incline and around a loop at each side of the terminal, making an arrangement whereby a very large traffic can be handled in a most efficacious manner.

THE DRAINAGE OF NEW ORLEANS.

By L. W. Brown, M. Am. Soc. C. E.*

The city of New Orleans, while one of the oldest, is the last of the several large cities of the Union to inaugurate municipal improvements of the character and on the scale that this progressive age demands for their proper welfare, convenience and prosperity. It will, perhaps, prove of

*Chief Engineer National Contracting Co., New Orleans, La.

material advantage to the city of New Orleans that these works have been deferred, as an opportunity will be presented whereby the very highest perfection of design and construction could be obtained by reason of the experience gained in matters of municipal improvements as compared with the practice of 25 years ago. As a consequence, there is reason to believe that New Orleans will, as the best sewered, watered and drained city in the United States, coupled with her geographical location, regain, in the very near future, her position as the foremost city of the country in commerce, population and wealth.

There are several reasons why New Orleans was backward in the inauguration of the necessary extensive municipal improvements, the principal one being, want of funds, caused, as can be readily understood, by the legacy of the War of the Rebellion, and by the fact that the conditions governing these improvements are such as to require an expenditure very considerably in excess of that demanded for cities more favorably located. The city has, however, now reached a position where the subject of drainage, sewerage and water is no longer a question of doubt, but is an assured fact. The drainage works, to which these papers refer, are now in course of execution, and the work in connection with sewerage and water is emerging from the legislative stage.

Description of Investigation.—Active measures in making necessary research and formulating plans for the drainage of New Orleans, were inaugurated under the direction of the writer as City Engineer, in 1892, and completed in 1896, with Majors B. M. Harrod and H. B. Richardson, of New Orleans, and Mr. Rudolph Hering, of New York, as Advisory or Consulting Engineers, and construction of the work was started during the latter part of 1897 under a board of commissioners appoined by the Legislature of the State of Louisiana, with Major B. M. Harrod as Chief Engineer. The investigation and study of the drainage work were most interesting, and developed the fact that to secure satisfactory results the solution was an intricate one. The investigation that was made embraced a complete topographic and hypsometric survey, precise recording and calculation of precipitation, close observation of proportion of run-off existing compared with desirable conditions, as also the economy, or rather extravagance, of existing methods of pumping.

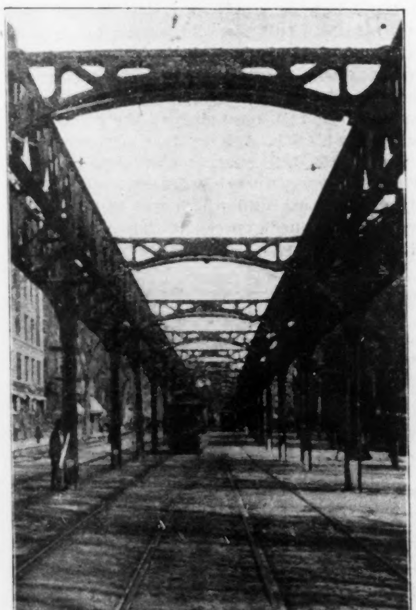


Fig. 5.—View of Boston Elevated Railway, Showing Attractive Appearance of the Structure and Street.

The topography covered the careful delineation of the existing areas of the city, with comparative density of improvements, as this density regulated the volume, or rather the time of run-off, and consequently formed the key for the proportioning of drains, canals and pumps. The areas as classified were four in number, and were designated as "A," "B," "C" and "D." "A" representing areas where streets were paved and adjacent property closely built upon, and from which the greatest amount of immediate run-off would be secured; "B" representing areas having a medium density of improvements, buildings not close and with small yards, from which would be secured a medium amount of immediate run-off; "C" representing areas which are sparsely built upon, having large yards, from which the immediate run-off would be considerably less than that from areas "A" and "B"; "D" representing areas which are comparatively rural, or which are not improved to any great extent, and from which the immediate run-off would be quite limited.

The results of this topographical survey, in conjunction with the information secured from the hypsometric survey, fixing of grades and investigation as to precipitation and run-off, enabled a set of curves to be prepared, which were based on a thorough study of the results of these several investigations. These curves represent the run-off for which drains, canals and pumps were to be provided to suit the several areas as to their comparative density of improvement and their grade; and these curves also represent the volume of water in cubic feet which would reach the drains, canals and pumps from a given area of each of the several classes of territory according to the best obtainable grade of street delivery. The location and extent of these several areas as now existing, and the drains, canal and pumps now being built (or proposed) to meet the requirements of the future growth of the city, are shown in Fig. 1.

The hypsometric survey embraced the precise leveling of the whole territory and the establishment of convenient bench marks. Referring to the result of this survey, as shown in contour in Fig. 2, it will appear that to properly drain this territory there is required more than ordinary measures. It will be observed that the area is large (26,000 acres), and the difference in elevation very small, and that large portions of the city are below ocean level, and the entire city is below high water in the Mississippi River; hence a gravity outfall is impossible. It will also be observed that the city is protected against inundation from the river and sea by levees varying from 5 to 16 ft. high, extending entirely around the area occupied, as shown in Fig. 2. Some of the ruling elevations are given as follows:

	*Cairo datum.
Highest water in Mississippi River, 1897	38.45 ft.
Portion of city directly adjacent to river levee	33.00 "
Lowest portion of city	19.50 "
Mean ocean level in Lake Ponchartrain	21.46 "
Mean ocean level in Lake Borgne	21.26 "

*This "Cairo datum" was arbitrarily established by the Mississippi River Commission, and refers to a plane 21.23 ft. below mean ocean level as established at Biloxi on the Mississippi Sound, which has been recently corrected as 21.548, but which correction is not adopted in New Orleans work.

The precipitation was accurately registered by the placing of six "Frieze" self-registering rain

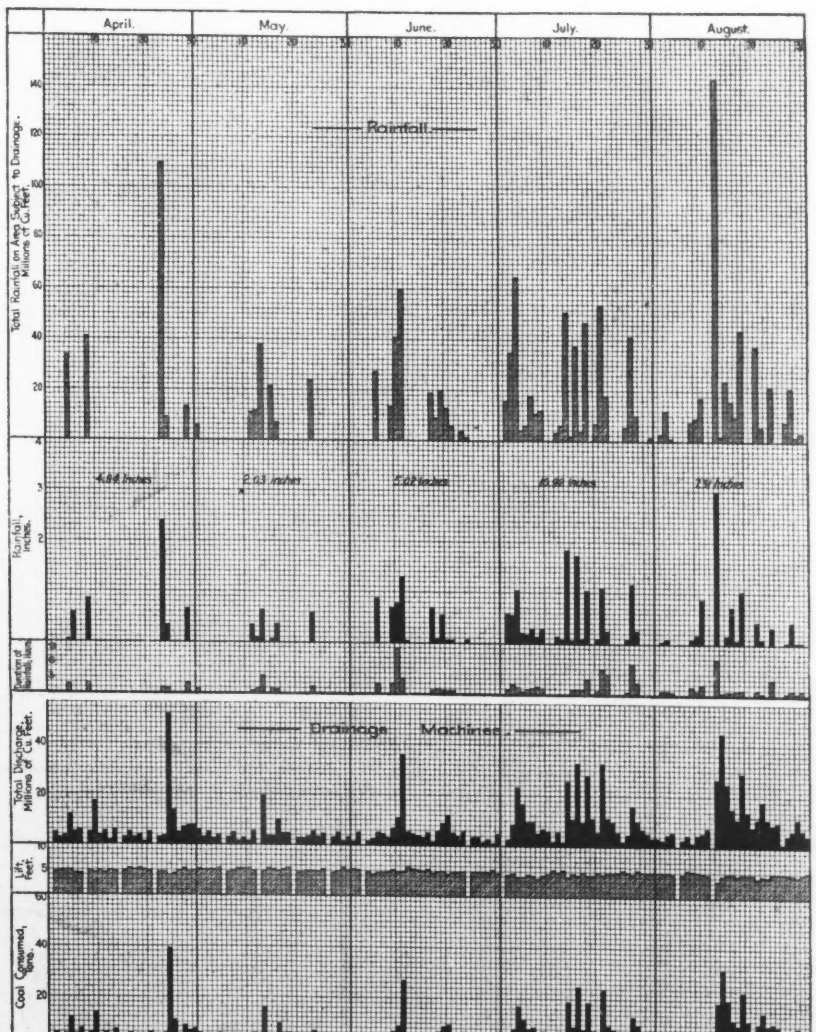
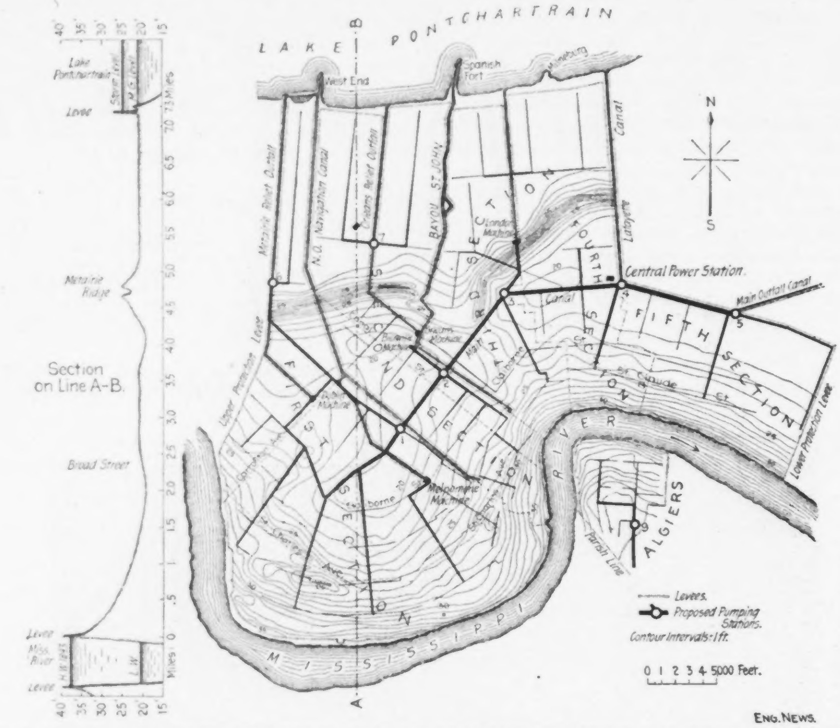


FIG. 3.—RAINFALL AND DISCHARGE, APRIL TO AUGUST, 1894, INCLUSIVE.

gages at such points throughout the territory as to secure the best results, and admit of the best judgment in averaging and calculating aggregate volume. The value of rain gages for municipal work, especially in a tropical or semi-tropical country, or where the rainfall is very intense, cannot be overestimated, and the record of these gages in New Orleans is very interesting.

Fig. 3 is a diagram representing for each day from April to December (inclusive), 1894, the rainfall in inches, precipitation in million cubic feet on the area subject to drainage, duration of rainfall in hours, volumes pumped in million cubic feet, height to which water is pumped in feet, and coal consumed in tons. Referring to the storm of August 13, 1894, it will appear that the total precipitation of this storm was 2.96 ins., and that 2.75 ins. fell in one hour, the most intense portion of the storm being .5-ins. in 5 minutes, or at the rate of 6 ins. per hour. Referring to Fig. 3, the volume of this precipitation on the area then subject to drainage, was 143,000,000 cu. ft. On July 4, 1894, a storm occurred which registered an intensity in precipitation for 5 minutes of .6-in., or at the rate of 7.2 ins. per hour, and the aggregate of precipitation from this storm was 2.84 ins., and in one hour's time 2.81 ins. fell, or practically the whole of the storm.



FIGS. 1 AND 2.—DRAINAGE SECTIONS OF NEW ORLEANS; PUMPING STATIONS AND PROPOSED CANALS AND DRAINAGE SYSTEM, TOGETHER WITH CONTOUR MAP OF NEW ORLEANS.

The following is a table of storms occurring in New Orleans between April 1 and Dec. 31, 1894, having a total precipitation exceeding 0.50 ins. The table gives the date, maximum intensity in 5 minutes maximum rate per hour, duration of storm and maximum precipitation in inches in one hour, as automatically registered at City Hall Station:

Date.	Precipitation: Maximum per 5 minutes in ins.	Precipitation: Rate, per hr. in ins.	Precipitation: Total, in ins.	Duration hr.	Duration min.	Maximum precipitation in ins. for 1 hr.
April 4....	0.26	3.12	0.59	1	35	0.60
" 9....	0.30	3.60	0.85	2	10	0.60
" 24....	0.45	5.40	2.40	2	00	1.90
" 29....	....	....	0.67	3	10	....
May 14....	0.15	1.80	0.60	2	00	0.37
June 6....	0.30	3.60	0.80	0	50	0.45
" 9....	0.25	3.00	1.12	1	00	0.70
" 11....	0.23	2.76	1.01	2	50	0.60
" 17....	0.25	3.00	0.70	0	15	0.70
" 18....	0.15	1.80	0.60	0	40	0.60
July 2....	0.30	3.60	0.55	0	25	0.55
" 4....	0.35	4.20	1.56	3	00	1.10
" 14....	0.40	4.80	1.82	0	55	1.82
" 16....	0.30	3.60	1.70	0	55	1.70
" 18....	0.20	2.40	0.81	0	25	0.81
" 20....	0.15	1.80	1.10	3	20	0.48
" 27....	0.15	1.80	1.34	3	15	0.50
Aug. 13....	0.50	6.00	2.96	6	30	2.75
" 16....	0.40	4.80	0.70	0	25	0.70
" 18....	0.25	3.00	1.01	1	00	1.01
Oct. 28....	0.15	1.80	0.88	1	25	0.35
Nov. 2....	0.10	1.20	0.68	3	00	0.33
Dec. 26....	0.15	1.80	0.89	3	00	0.70
" 30....	....	....	0.57	4	00	....

As will be noted, the above table is the record of the automatic gage at the City Hall Station; and referring to the rainfall of July 4, 1894, it will be observed that the intensity as also the aggregate volume of precipitation of this storm at the City Hall Station was very much less than was registered at the Park Station, located about three miles to the Southwest, where, as above noted, the intensity of the precipitation was at a rate exceeding 7 inches per hour.

The following is a table showing date and total precipitation of storms which have occurred in New Orleans, from 1871 to April, 1894, where the total precipitation was in excess of 2.5 ins. in 24 hours, gaged by the New Orleans Station of the U. S. Department of Agriculture—Weather Bureau:

Date.	Ins.
1871—Oct. 2, 3........	2.95
Oct. 30	3.04
Nov. 12, 13	2.80
1872—Mar. 24, 25.....	4.50
Nov. 7, 8........	4.48
Dec. 18	2.54
1873—May 5, 6.........	3.98
May 20	3.29
Aug. 20, 21.....	4.08
Nov. 4, 5	2.61
1874—April 16.	3.84
July 3, 4	7.52
1875—Feb. 19	3.71
Mar. 11, 12	2.75
Mar. 28, 30	3.81
April 20, 21	2.90
Aug. 11, 12.....	2.77
Sept. 25	5.28
Dec. 4	3.82
1876—Mar. 19	3.98
Mar. 27	3.72
April 7	5.51
May 7, 8	4.09
Nov. 2	2.61
Dec. 31	2.59
1877—Mar. 1	5.02
Sept. 17, 18	7.22
Oct. 24, 25......	2.54
Oct. 29, 30	3.52
1878—Mar. 9	2.73
May 19	3.54
July 21	2.74
1879—April 16	2.82
Aug. 13, 14	2.60
1880—Mar. 8, 9	3.36
1881—Jan. 3	2.82
July 3	3.25
Nov. 6	2.99
Dec. 13, 14.....	2.32
1882—.....	None.
1883—Jan. 18, 19	3.71
Mar. 24	2.60
April 7, 8......	9.22
June 8, 9	2.68
1884—April 4, 5	2.96
1885—Jan. 4, 5........	2.62
Sept. 20	2.78
Sept. 25, 26.....	3.23
Dec. 12, 13	3.40
1886—Jan. 14, 15	4.47
April 27, 28	2.67
1887—June 29	5.47
Sept. 26, 27	2.88
Oct. 18, 19	3.19
1888—Feb. 20, 21	2.72
Feb. 23, 24	4.21
June 6	2.88
June 26	4.44
Aug. 14, 15	3.70
Aug. 19, 20.....	8.90
Aug. 24, 25	2.80
Oct 22, 23	4.13
1889—June 26, ...	2.86
June 30	2.76
1890—June 22, 23	3.08
Oct. 15, 16	2.63
1891—Feb. 14, 15	2.69
Dec. 14, 15	2.92
1892—Jan. 10, 11	2.85
April 21, 22	1.49
Aug. 15, 16	3.83
1893—Feb. 11, 12	2.72
April 19*	2.88
June 5, 6	3.02
Oct. 1, 2	2.75
Nov. 26, 27†	3.35
1894—Feb. 20, 21‡....	3.59

*8 hours 40 minutes.
†9 hours 30 minutes.
‡24 hours.

The following is a table showing the date and total precipitation of storms, which have occurred in New Orleans from 1871 to April, 1894, when the rate of precipitation exceeded 1 inch per hour, gaged by the New Orleans Station of the U. S. Department of Agriculture—Weather Bureau:

Date.	Ins.
1871—June 30	1.10
July 31	1.16
1872—.....	None.
1873—May 20	1,47
1874—....	None.
1875—...	"
1876—....	"
1877—.....	"
1878—....	"
1879—April 16	1.00
Aug. 13	1.00
1880—Aug. 3	1.17
1881—June 6	1.30
July 3	2.48
1882—July 16..	1.30
1883—.....	None.
1884—July 4	1.00
Oct. 21	1.00
1885—....	None.
1886—.....	"
1887—.........	"
1888—Feb. 23	1.27
May 24....	1.25
June 6	2.00
Aug. 20 (est.)...	3.00
1888—Aug. 24	2.56
Oct. 22	2.00
1889—June	1.19
June 30	1.50
July 6 (15 min.).	1.40
" 8	1.35
" 9	1.04
" 12	1.20
" 13 (30 min.)	1.15
Sept.25 (30 min.)	1.39
1890—April 17 (45 min.)	1.70
June 22 (30 min)	1.25
July 7 (30 min.)	1.00
Sept. 10	1.05
Oct. 15	1.50
Dec. 25	1.25
1891—.....	None.
1892—April 21 (2 hrs.)	2.90
April 22	1.06
May 9	1.13
July 7	1.26
Aug. 16	1.07
1893—April 19	1.40
Nov. 26 (2 hrs.)	2.00
Dec. 12 (45 min.)	1.00

Information as to existing run-off was secured by the construction of flumes in each of the existing out-fall canals and measuring the volume of water delivered from existing drainage stations, by "Price Current Meters;" the area of channel being very carefully measured and the average velocity secured by the integration of the whole area of channel by the meter, and the very careful consideration and study of the result of these investigations. The result demonstrated that to provide satisfactory drainage, it was necessary to meet the following conditions: 1st. An aggregate annual rainfall of 64 ins. 2d. Owing to our semi-tropical position the precipitation is very intense, approximating a maximum of 3 ins. per hour, and at the rate of 6 ins. per hour for 10 minutes. 3d. No gravity out-fall, requiring all the precipitation to be pumped. 4th. A large territory, practically flat, very little difference in elevations. 5th. An alluvial soil, very unstable for excavation, practically at sea level, and which was in earlier time covered by immense cypress swamps, which as the city improved, were filled, the stumps remaining.

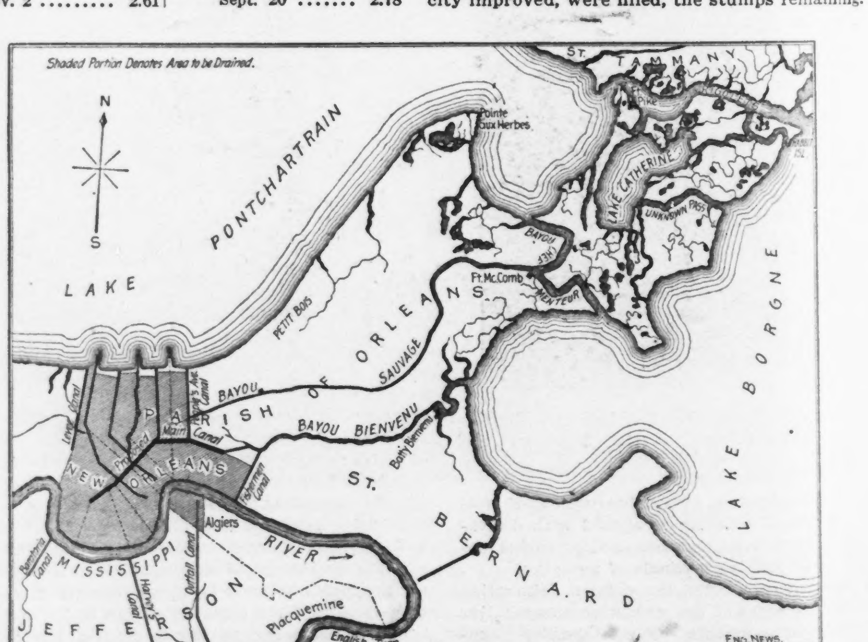


FIG. 4.—MAP OF NEW ORLEANS AND VICINITY, SHOWING THE LOCATION OF THE OUTFALLS.

Description of System.—The question of proper out-fall for the drainage of the city was a matter which also required very careful consideration. Fig. 4 shows the relative position of the city with the most available out-falls, Lake Ponchartrain, Lake Borgne and the Mississippi River. The out-fall into the Mississippi River, while it would be advantageous, could not be entertained owing to the very high lift that would be required. Lake Ponchartrain, which forms the Northern boundary of the city, and which is a lake 22 miles wide and 45 miles long, is practically land-locked, its only connection with Lake Borgne and the Mississippi Sound being through two narrow channels, the Rigolets and Chef Menteur, and consequently has very little or no daily circulation, or tidal influence; heavy easterly winds and storms, which frequently prevail, force the water from the Mississippi Sound through these two small channels and the water in the lake, after these storms, recedes slowly, and several days elapse before its normal height is reached. For this reason, as also to avoid polluting the lake directly adjacent to the city with drainage water, it was decided best to make Lake Borgne the out-fall for all the daily and highly polluted drainage, and as much of that from heavy storms as possible. It will be observed that Lake Borgne opens directly into the Mississippi Sound, and is in reality a "bay," and is directly affected by the tidal influence of the Gulf of Mexico. As will be described later, Lake Ponchartrain will be used as an out-fall during heavy storms, or when the run-off exceeds the discharging capacity of such main canal as it was determined practicable to build, leading towards Lake Borgne, which capacity was determined by fixing the maximum capacity of the final pumping station delivering to Lake Borgne at 3,000 cu. ft. per second.

The existence of a ridge between the river and Lake Ponchartrain, as shown by the contours on Fig. 2, makes the natural drainage of the major portion of the city in the line of the proposed main canal and Bayou Bienvenu to Lake Borgne, they being located directly in the bottom of the basin.

Having determined upon the out-fall, and having in hand the information as to the volume of precipitation which had to be provided for, as also the grades of the territory, it was found that it would be impossible to convey the necessary volume of water through a canal, which it would be practicable to build in our soil directly to the main out-fall station discharging into Lake Borgne; and after very careful consideration and study of the subject it was determined to be not only expedient, but absolutely necessary, in order to secure proper discharging capacity in such a canal, to lift the water at four points throughout its length, and thus form what may be termed, artificial slopes in the main canal, which is six miles long; and these low-lift pumping stations in the main canal are located at such points in its length as to drain the large tributary canals.

The city was divided into five drainage sections—the location and extent of each section, together with the location of collecting and delivering drains and canals are shown in Fig. 1, as also the location of main canal and pumping stations. There are five pumping stations on the line of the main canal, numbers 1 to 5, inclusive; station No. 5 is the final out-fall station delivering the drainage to Lake Borgne; stations No. 1 to No. 4, inclusive, are low-lift stations, their function being to deliver the drainage from the sections in which they are located into the main canal, as also to deliver all the water reaching the several stations from the main canal, to a higher level and delivering it in the direction of the final out-fall station to Lake Borgne, and thus create what may be termed an artificial slope in the main canal between each pumping station, and provide a measure for securing the delivery of the maximum volume of drainage to Lake Borgne. Figs. 5 and 5a show the general arrangement of the main canal as above described, as also the lift at each of the several stations.

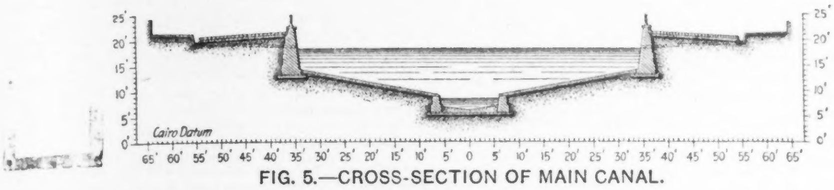


FIG. 5.—CROSS-SECTION OF MAIN CANAL.

The main canal from station No. 1 to No. 5, is approximately six miles long, and the maximum delivering capacity at station No. 5 is 3,000 cu. ft. of drainage per second; and although this quantity of drainage will be exceeded during very heavy or extraordinary precipitation, it was not considered practical or economical to deliver more. Pumping stations No. 6 and No. 7 are what may be termed relief stations, and are required only when the volume of drainage exceeds the capacity of the main canal between pumping stations No. 1 and No. 2, and between No. 2 and No. 3, at which times this surplus will be delivered by stations No. 1 and No. 2, through the relief canals towards stations No. 6 and No. 7, respectively, and by them delivered into their respective out-falls connecting with Lake Ponchartrain. During dry weather and for light and moderate storms, or when the aggregate of drainage does not exceed the maximum capacity of the main canal, the two relief canals act as tributary canals to pumping stations No. 1 and No. 2, under which conditions these stations receive and deliver into the main canal the drainage from the entire section in which they are located. Fig. 6 shows a profile of the Orleans Relief Canal, leading from pumping station No. 2 to pumping station No. 7; profile of out-fall from station No. 7.

During periods when maximum precipitation occurs, the operation of the system will be as follows: The drainage from the major portion of Drainage Section No. 1, or that portion between the river and the main canal, will be collected by the various canals in the section and delivered to pumping station No. 1, where by one set of pumps, a portion of the drainage water will be lifted and delivered into the main canal in direction of pumping station No. 2, which portion will be equal to the maximum discharging capacity of the main canal between pumping stations No. 1 and No. 2. The balance of the water, which will be received at pumping station No. 1, will be lifted by another set of pumps and delivered into the relief canal in direction of pumping station No. 6, where it, together with the drainage from the portion of Drainage Section No. 1, adjacent to Lake Ponchartrain, will be lifted and delivered into the relief out-fall and discharged into Lake Ponchartrain. The drainage water from the front or river portion of Drainage Section No. 2, will be collected and delivered to pumping station No. 2, and meet the volume delivered into main canal by pumping station No. 1; and such portions of this aggregate volume as is determined by the discharging capacity of the main canal between pumping stations No. 2 and No. 3, will be lifted by one set of pumps at pumping station No. 2 and delivered into the main canal in direction of pumping station No. 3. The balance of water received at pumping station No. 2 will be lifted by another set of pumps and delivered into the relief canal towards pumping station No. 7, where it, together with the drainage water from the rear or lake portion of Drainage Section No. 2, will be lifted and delivered into the relief out-fall canal and discharged into Lake Ponchartrain.

The drainage from the entire area of Drainage Section No. 3 is collected and delivered to pumping station No. 3, where it, together with the volume delivered into main canal by pumping station No. 2, is lifted and delivered into the main canal towards pumping station No. 4. The entire drainage from Drainage Section No. 4 is collected and delivered to pumping station No. 4, where it, together with the volume delivered into main canal by pumping station No. 3, is lifted and delivered into main canal towards pumping station No. 5. The drainage from Drainage Section No. 5 is delivered direct to the main out-fall pumping station No. 5, where it, together with volume delivered into main canal by pumping station No. 4, is lifted and delivered into the main out-fall and discharged into Lake Borgne.

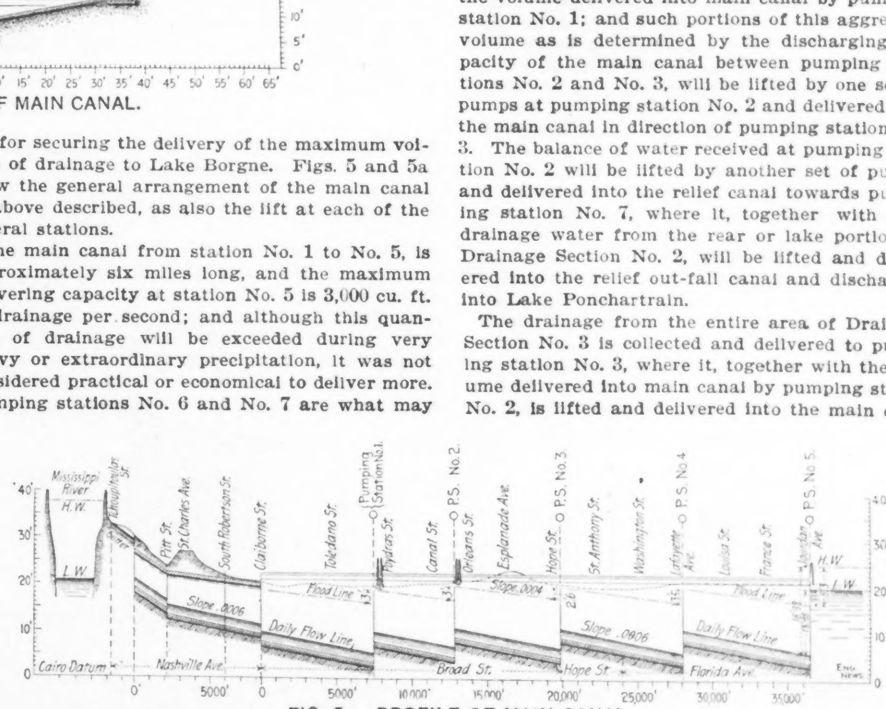


FIG. 5a.—PROFILE OF MAIN CANAL.

Summarizing, when the aggregate volume of drainage from the whole city does not exceed a delivery of 3,000 cu. ft. per second at the main out-fall pumping station No. 5, relief pumping stations No. 6 and No. 7 are not operated, and the relief canals are turned into tributary canals flowing towards the main canal; and when the aggregate volume of drainage exceeds a delivery of 3,000 cu. ft. per second at the main out-fall pumping station No. 5, pumping stations Nos. 6 and 7, deliver into Lake Ponchartrain from Drainage Sections No. 1 and No. 2, the volume representing the excess from the two sections of that required to provide, in conjunction with the volumes from Drainage Sections No. 3, No. 4 and No. 5, the maximum capacity of the main out-fall pumping station No. 5.

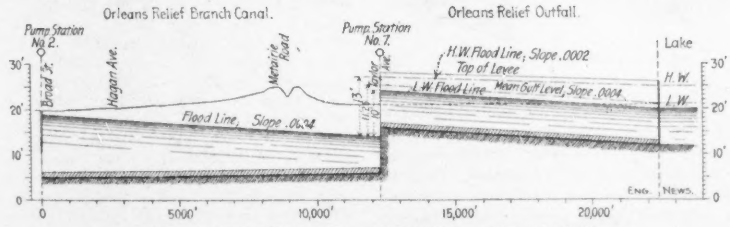


FIG. 6.—PROFILE OF ORLEANS RELIEF CANAL.

In the location of canals and pumping stations, every possible endeavor was made to secure the best economy in construction and convenience for operation consistent with the aims of the project, and very thorough consideration was given in the design to secure a system which would admit of its construction at such rate as funds may be found available, and enable full benefits to be obtained from the partial construction of the work. As a result, in 1897, only sufficient funds were available to execute portions of the work in the First and Second Drainage Sections, which are now about completed, and great benefits have accrued, especially to the front or river portion of the Second Drainage Section, which comprises the main commercial portion of the city. The portions of this work now about completed, and to which the following papers on detail of construction, plant, etc., refer, embrace all the covered canals in the Second Drainage Section, located between the river and main canal; pumping stations Nos. 2, 6 and 7; Central Electric Power Station, and the open relief and out-fall canals in the First and Second Drainage Sections.

In 1897, the Drainage Commission advertised for proposals for the construction of the above enumerated work, and the contract was awarded to the National Contracting Company, of New York, and the writer was engaged by this company as Chief Engineer. To secure comparative estimates, proposals were requested and submitted for the operation of the three pumping stations by steam and by electricity, and the latter was adopted. Active work was inaugurated in February, 1898, and uninterruptedly continued, and is now about completed.

To clearly describe the details of the work it will, perhaps, be proper to classify these and refer to each class under the following heads:

Lined and covered canals.
Unlined and open canals.
Pumping Stations.
Central Power Plant.
Electrical Installation.
Transmission line.

The following is an approximate aggregate of the quantities of the principal items of materials used in the work as now completed, not including building and machinery. The method of handling and proportions will be referred to in description of the several classes of work:

Excavation	570,000 cu. yds.
Brick work (about 26,000,000 bricks)	52,000 " "
Concrete	33,000 " "
Timber	8,600,000 ft. B. M.
Piling	557,471 lin. ft.
Rolled steel	2,540 tons.
Cast-iron	680 tons.
Concrete pavement	34,000 sq. yds.

(To be continued.)

THE ABOLITION OF GRADE CROSSINGS IN DETROIT, MICH.

After some seven years of agitation in the city of Detroit concerning the removal of railway grade crossings from the streets, definite action seems likely to be taken at an early date. That this is the case appears to be largely due to the present Mayor of Detroit, Hon. Wm. C. Maybury. In September last he sent a message to the Common Council urging the complete abolition of railway grade crossings in the city, and expressing the opinion that the railway companies would consent to undertake the work if the matter were properly brought before them. In response to this request a special committee was appointed, and a conference was held between its members and the officers of the principal railways affected on Nov. 18 last. At that conference the representatives of the Lake Shore, Michigan Central and Grand Trunk companies offered to undertake the work of elevating their tracks and pay 70% of the cost if the city would assume the remaining 30%. Depression of the tracks, which had been proposed, was opposed by the railway representatives on the ground that large property damages would result, difficulties would occur in drainage, and danger to railway employees would result from the numerous overhead bridges.

On Nov. 24, a party of aldermen and other city officials visited Buffalo and examined the work in grade crossing removal which has been done there, being escorted by Mayor Diehl and E. B. Guthrie, M. Am. Soc. C. E., Chief Engineer of the Buffalo grade crossing commission. A week later the same party visited Chicago and spent a day examining the work of grade crossing removal that has been done there. About the close of the year the situation in Detroit was examined and reported upon by Mr. John O'Neill, Supt. of Track Elevation in Chicago, and by Mr. Guthrie. The former advised the general elevation of all tracks. Mr. Guthrie advised the elevation of the tracks on the west side of the city and their depression on the east and south sides; this would cause about two-thirds of the new street crossings to be made through subways, and the remainder over viaducts. Mr. Guthrie's report also coincides with the opinion expressed by Mr. McCormick, City Engineer of Detroit.

On Feb. 16, another conference was held at the City Engineer's office at which the heads of the engineering departments of the railway companies were represented. City Engineer McCormick presented plans and specifications for partial elevation and partial depression of the tracks at an estimated cost of about $4,000,000. The plan is under examination by the railway engineers, and further definite action is probable at an early date, as public opinion has been much aroused over the frequent grade crossing accidents, and is spurring on the city authorities to action. We are indebted to Mr. Geo. Brown, of the Detroit "Evening News," for the information from which the above article has been prepared.

FINISHING TOOLS FOR FACING THE GROOVES AND RINGS OF PISTONS.

The finishing tools which we illustrate herewith are said to produce as smooth and true surfaces as can be obtained by grinding. The tool for finishing the ring grooves of piston heads is shown in Fig. 1. It is provided, after the style of milling-machine finishing tools, with a number of small teeth, and the shank of the tool is provided with a groove so that the tool may be held firmly and still be free to rotate in the tool-holder of the lathe. The tool for finishing piston rings, which

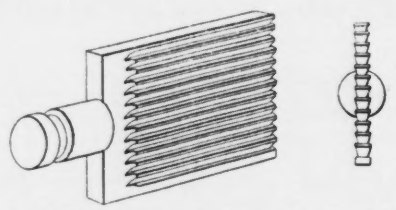


Fig. 1.—Tool for Facing the Ring Grooves of Piston Heads.

is shown in Fig. 2, is constructed in the same manner, except, of course, that the cutting edges point toward each other rather than away from each other. It is said that with these tools there is absolutely no chattering, the work is accurate to less than 1-1,000-in., and the two surfaces are perfectly parallel. It is well known that these conditions are necessary to secure smooth working without leakage in the pistons of steam and gas engines. We are informed that these tools

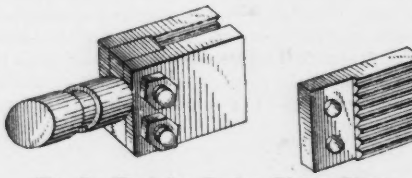


Fig. 2.—Tool for Facing Piston Rings.

have been used by the Westinghouse Machine Co., of Pittsburg, Pa., for finishing the pistons of gas engines, and with very satisfactory results. The inventors of the device are Messrs. Josiah Pearce and George H. Jackson, of Swissvale, Pa., to whom we are indebted for the foregoing information and the material used in the illustrations. The patents on the tools are Nos. 681,884 and 681,885, issued Jan. 23, 1900.

THE MAINTENANCE AND INSPECTION OF AUTOMATIC ELECTRIC BLOCK SIGNALS.*

By H. S. Balliet.†

The automatic block signal of to-day supplies the best and proper protection for the quick and safe handling of railway traffic. As block signals are indications by which the train crews receive information as to the condition of the line ahead, without stopping, the value of such indications is dependent upon the accurate and complete information displayed. These indications, if correct, will show danger with an open switch, a broken rail (which is sufficiently separated at the break so as to destroy the electrical connection), a train in the section, or a pair of wheels which may rest on both rails of the track section.

In considering the maintenance and inspection of an automatic block system, we will treat with one installed on a double track road, with both tracks protected. All switches and crossovers leading to the main track, or in the main track, protected by breaking the signal wire of the home signal, through the switch instrument attached to switch points, with a very close adjustment, so as to give a danger indication should the point be partly open, or the switch set wrong. Track circuit sections are ½ to ⅝-mile in length. Each section is equipped with two electro-magnets, one of them being in series with the rails and battery, the other (which is of a higher resistance) being in multiple with the rails and battery, at the battery end. Two cells of gravity battery in multiple arc supply the energy for these circuits. One distant and one home signal are on each circuit, normally at "danger." There is a visual switch indication at each siding or crossover, normally at "safety."

In order properly and economically to maintain and operate such a system there should be a repairman and batteryman to every 15 miles of double track. As near as possible the headquarters of these men should be in the middle of the territory, being located where there is a day and night telegraph office. Too much care cannot be exercised in keeping good bond wires on all joints, with proper contact in the holes drilled into the rails, so as to cause no high resistance in the sections. These men should do all the bonding, or superintend the work is too much for them to do in person.

Each cell of track battery should be renewed every fourth week, and in order to give satisfactory service these cells should be "patched" the second week after renewal. This is to be done by removing the zinc and thoroughly cleaning it, removing a given quantity of zinc solution and replacing it with clear water. Under some very favorable conditions these rules might safely be made to read "renewal" every six weeks and "patching" every third week. Zincs should have a large surface exposed in these batteries, the 4-lb. circular being about the best. These zincs should not be left in service after they are three-fourths consumed.

No copper should remain in a track battery in continuous service for more than three months. It should be removed and thoroughly dried. The copper collections should be carefully removed, and on some subsequent trip it can again be restored to service. The blue stone should be carefully washed and screened when washing these cells. All copper collections and refuse should be separated from the blue stone so as to leave it in first-class condition.

Whenever practical a given number of gravity signal batteries should be installed in which to use the zincs removed from track batteries. This is more economical than to sell the small zincs for scrap. In a signal battery these zincs can be used until they are ready to fall apart. A better plan, however, is to get this material in good condition and turn it over to the telegraph department to use in their locals or mains.

The Gordon No. 1 cell, Excelsior cell, or Lalande (all 6 × 8) are among the most economical and easiest to maintain on both signal and indicator circuits. They are clean, easily removed and non-freezing, and on account of their long life, great labor savers.

Every division which does not exceed 75 miles of double track should be in charge of an inspector or foreman having charge of the automatic signal force which represents the maintenance of the division. All matters relating to maintenance should be handled by him. He should be held directly responsible for the proper working of all apparatus on his division. Where disc signals are in service, he should be required to renew all banners when they become faded; see that relay contact points are kept clean and have an even and perfect contact at all times; that all relay points break properly; that the adjustment of no instruments is made without his personal supervision or knowledge; that all wires are kept properly fused and protected against lightning; that all ground connections are in perfect order; that all batteries are properly renewed and at the proper time; that all alterations or changes in circuits are done properly so as to be safe and cause no unnecessary stops to traffic. He is also responsible for the hiring of proper men to maintain the system. He should report to the division superintendent and to the signal engineer.

Under such a system as described, the very best results will be reached. The following figures show an average cost for the service:

Cost per signal per year (labor and material)	$52.00
Cost per cell of track battery per year (material)	2.05
Cost per cell of signal battery per year, with indicators (material)	1.60
Cost per cell of signal battery per year, without indicators (material)	.90
Cost per cell of signal battery per year, gravity cells (material)	2.00

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