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CONDUCTED BY HENRY C. MEYER.

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(INCLUSIVE).

WOODBRIDGE BUILDING, 100 WILLIAM STREET, (Corner of John) NEW YORK.

GENERAL SUBJECTS.

A.

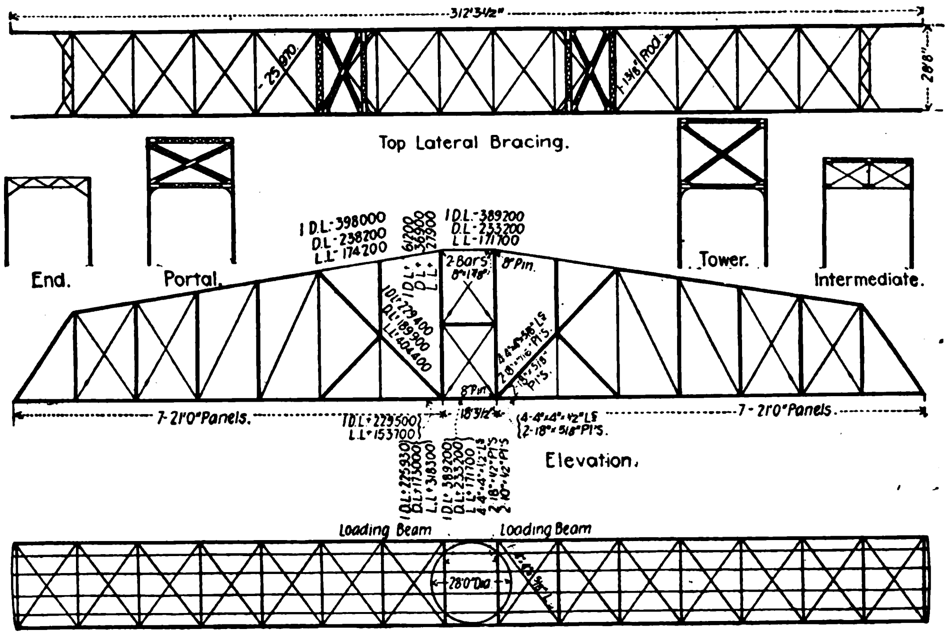
Aeronautical Annual, The.
Air Blast:
  Cleaning structural iron work by, 356.(I)
  Painting iron work by, 510.(I)
Air, Compressed:
  As motive power on the elevated railroad, 279.
  Pneumatic postal tube system in New York city, 444.(I)
Air: Reliability of anemometers, 210.
Albany, N. Y., water meters and politics in, 463.
Altona, Germany: Relation of water supply and cholera cases in the epidemic of 1892, 251.(I)
Altoona, Pa.: Sewage disposal plant, 204.(I)
American Public Health Association:
  Meeting, 421, 487.
  Report on disposal of garbage and refuse, 494.
American Society of Municipal Improvements: Convention at Nashville, Tenn., 433.
American Tract Society Building:
  Accident to elevator, 336,(I) 355.
  Management of elevator machinery, 332.(E)
Anemometers, reliability of, 210.
"Aquarius": "Waterworks for Small Cities and Towns," 8,(I) 72, 139, 184,(I) 249,(I) 292,(I) 379,(I) 423, 492.
Architects:
  Appointment of the supervising, 443.
  Competitive examination plan for U. S. supervising, 320.
  Esprit de corps among, 530.
  Examination for Supervising Architect of the Treasury, 158, 320.
  Scholarship of Boston Architectural Club, 156.
Architectural Competitions:
  For College of the City of New York, 486.
  For Mexican Capital, 266.
  For Academy of Design, New York, 537.
  For National Academy of Design, 376.
  For New York Public Library, 1, 158, 201, 523.
For Pennsylvania State Capitol, 331,(E) 345, 353, 358, 375,(E) 377, 381, 410, 421, 441,(E) 442, 452, 457, 463.
  Proposed for University of California, 209.
Architectural Societies:
  American Institute of Architects, 191, 276, 367, 410.
  Architectural League of New York, 5.
Architecture: The Government architect and public buildings, 46.
Armor Plate:
  Concerning a Government armor plant, 463.(E)
  Offer for diagonal armor accepted, 223.
  Offer of rejected by the Government, 207.
  Price of, 147.
Arundel, England: Sewage disposal of, 357.(I)
Asphalt:
  A California plant, 155.
  Deposits of, Uncompahgre Reservation, Utah, 553.
  Portable plant, 442.
  Relining of, Queen Lane reservoir, Philadelphia, 508.
  Utah and Kentucky for pavements, 294.
  Utah asphaltic rock, 156.
Assessments: Theory and practice of special, 287.(E)
Atlanta, Ga.:
  Construction of Fulton County Jail, 516.(I) 538.(I)
  Electrolysis of water pipes, 486.
  Pavement question in, 179.
Augusta, Ga.: New water works for, 486.

B.

Bacteriology:
  Systematic study of organisms affecting water supplies, 221.(E)
Baltimore, Md.:
  Erecting court house, 28.(I)
  Laying large water mains, 535.(I)
  Report on the City College building, 35.
  Plan of rental for sewer service, 537.
  Report of the Sewerage Commission, 355.
Bath, England: Hollow wedge brick in old Roman work, 508.
Baths: Public, 265.(E)
Bellaire, O.: Proposed 850-foot span highway bridge, 555.(I)
Bellefontaine, O.:
  Cement pavements, 120.
  Portland cement concrete culverts for highways, 30.
Benjamin, Prof. C. H.: "Electricity versus Shafting in the Machine Shop," 11.
Berlin, Germany: Cost of construction and operation of garbage disposal works, 532(I), 558.
Bids:
  Balanced required on Erie Canal contracts, 310.
  Forms for sewer bids, 69.
  Requirements to prevent unbalanced in Jersey City, N. J., 245.
Billerica, Mass.: Considerations favoring the establishment of water works, 140.
Biology: In civil engineering, 265.(E)
Blast:
  Fired by lightning, 358.
  Large on Palisades, 381.
Blasting: On Chicago drainage canal, 136(I), 466.(I)
Boilers:
  Oil fuel in, 243.
  Rating of house heating, 78.
  Strength of riveted joints, 209.
  Test of a Cahall, 363.
  Test of, Grosvenordale Mill, 540.
  Test of a water-tube with volatile coal, 451.
  Two new hot-water heating, 80.(I)
  Working capacity of, 144.
  Working of, and engines, 254.
Bonds:
  Demand for municipal, 121.

SWING BRIDGES ON THE CHICAGO DRAINAGE CANAL.

THE virtual completion of excavation on the main channel of the Chicago Drainage Cana while it concludes the largest and most uncertain part of the expenditures, by no means terminates the construction of the great waterway nor does it provide for its immediate service for canal purposes. The Lake Michigan intake must be modified and enlarged, the mechanial controlling works at the lower end completed, and the tail race made before the flow can be controlled. Finally the various highway and railroad crossings where the roads were originally left undisturbed on earth or rock embankments left intervening between adjacent sections of excavation so as to form natural dykes or bulkheads, must now be carried on long span swing bridges and the banks removed to absolutely complete the excavation of the channel and remove all obstruction to the flow and ultimately to navigation. Designs and preparations for this work have been so vigorously prosecuted that contracts are now being invited for the tail race and bridges and those for the first two of the latter structures will be opened on November 8. There will be in all six double-track railroad and seven highway long span swing bridges over the main channel besides several railroad bridges over the Desplaines River and the unexampled eight track railroad swing bridge of 416 foot span and 3,500 tons weight for the Pan Handle crossing of the canal.

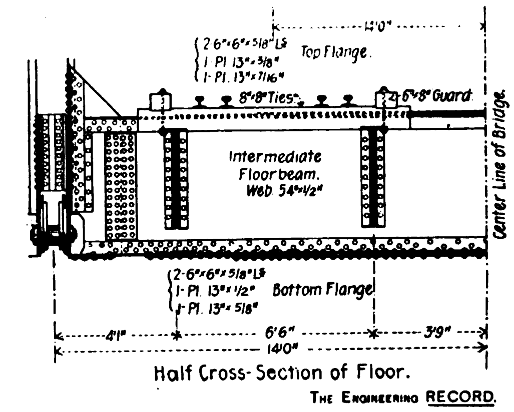


More than $1,000,000 direct expenditure is involved and plans, estimates and specifications have been in preparation for more than a year by the special department under Consulting Bridge Engineer William Hughes, M. Am. Soc. C. E., in charge of Mr. Edward Wilmann, C. E. Data has been formulated for the crossings of the Chicago, Madison and Northern Railroad near the east end of contract section N, and for that of the Chicago and Calumet Terminal Railway near the west end of contract section E, and the bids now invited upon the engineers' bids are required to conform to the following specifications and conditions although competitive plans conformable to the main features determined are solicted from the contractors and may receive the awards if they prove more acceptable and economical.

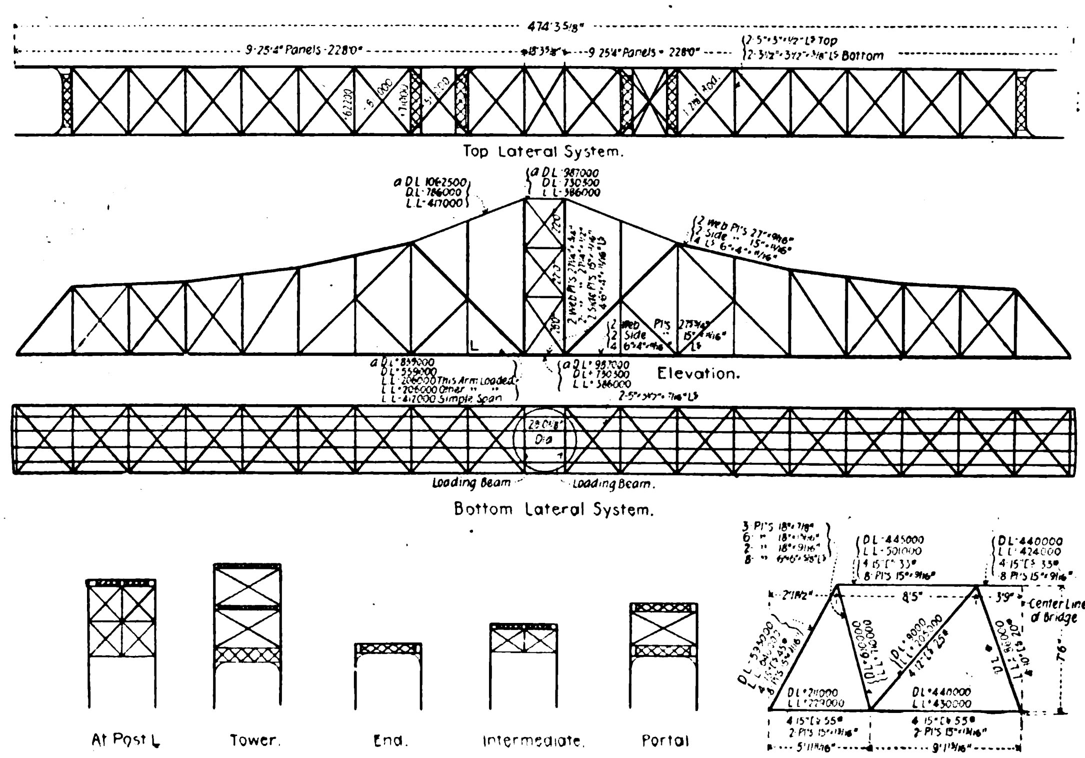
The accompanying diagrams show the truss outlines and a few typical maximum strains and sections to indicate the nature and magnitude of the chief members as given on the strain sheets issued, which also specify the following principal dimensions loading and materials. For the Chicago and Calumet Terminal Railroad there is required a dead load of 3,600 pounds per lineal foot of bridge; the ends touching the abutment seats and the ends raised 2 inches. The total deflection is assumed to be 4 inches; for live load strains the bridge is considered first as a continuous girder with a load of 4,000 pounds per square foot of track moving from abutment to pier; second, it is considered as a simple span with the same load extending from abutment to pier and with the same load extending from abutment across the pier; third, it is considered as a continuous girder of four supports with equal moments at the center supports.

The stringers have a maximum moment of 176,600 foot pounds and an end shear of 33,150 foot pounds. All stringers having 38½ inch by ⅜ inch webs and 4x4 inch flange angles. The intermediate floor beams have a maximum moment of 829,900 foot pounds and an end shear of 116,100 foot pounds. The end floor beams have a maximum moment of 662,900 foot pounds and an end shear of 97,680 foot pounds. The intermediate floor beams have 54 x ½ inch webs and 6 x 6 inch angles and 13 inch plates in the flanges. The end floor beams have 46½ inch by ½-inch webs. The drum is composed of a 70x½ inch web and four 6x6x½ inch angle flange.

For the Chicago, Madison & Northern Railroad there is required a dead load of 5,320 pounds per lineal foot of bridge, both ends touching the bridge seats and both ends raised 2 inches. The total deflection is assumed to be 6 inches. For live load the bridge is considered as a continuous girder with a load of 4,940 pounds per lineal foot of truss, moving from abutment to abutment on the near track; second, as a continuous girder with the same load on the far track; third, as a simple span with a load of 4,940 pounds per lineal



foot of truss moving from abutment to pier on the near track; fourth, as a simple span with the same load moving across the pier to the farther abutment on the far track; fifth, as a continuous girder of four supports with equal amounts at center supports. The intermediate floor beams have maximum moment 1,524,000 foot-pounds, maximum end shear 188,000 foot-pounds and are composed of one 60x⅜-inch web-plate with four 6x6-inch angles, four 6 inch and four 14-inch plates in the chord. The end floor beams have maximum moment of 1,162,000 foot-pounds; maximum end shear of 142,000 foot-pounds and are built with the same widths and numbers of plates and angles. The stringers have a maximum moment of 378,200 foot-pounds, maximum end shear of 64,800 foot-pounds and are built of a 51x⅜-inch web-plate and four 6x4x⁹⁄₁₆-inch angles. The drum has a 79x½-inch web-plate and four 6x6x⅝-inch chord angles. The stresses in the longitudinal bracing in the center panel were calculated to transfer a shear across this panel, due to an unbalanced load of 12,000 pounds suspended from one end of the bridge only.



BRIDGES OVER THE CHICAGO DRAINAGE CANAL.

THE OUTBREAK OF YELLOW FEVER has aroused the citizens of New Orleans to an appreciation of the necessity of placing their city in a thoroughly sanitary condition. At a mass meeting the plan was adopted of dividing the city into blocks with volunteer captains. Residents are to thoroughly clean their own premises and the streets and to see that they are kept clean and disinfected.

METHODS OF WORK AND SPECIAL PLANT ON THE CHICAGO DRAINAGE CANAL.

[BUILDERS' AND CONTRACTORS' ENGINEERING AND PLANT, NO. CCXLII.]

PART XXIX.—SECTIONS 11, 12 AND 13.—GENERAL DATA; LOCATION MAP AND PROFILE; DIAGRAM OF DISTRIBUTION OF PLANT; OPERATION OF INCLINES; VIEW OF ROCK DUMP FROM CANTILEVER; VIEW OF FRONT OF CANTILEVER, OF INCLINE TRACKS AND OF BLAST.*

SECTION 11 begins at survey station 1,268, and extends to station 1,320, its whole length of 5,200 feet being on a 36 minutes curve 10,326 feet in total length, that gives a deflection of 61° 57' between tangents at its extreme limits. The original contract was let in July, 1892, to Mason, Hoge & Co., who arranged the work so that 1,750 feet at the eastern end was conducted by Messrs. Rosser, Coleman & Hoge, and the remainder by Messrs. Locker, Harder & Williamson, all of the same firm, the work being completed in 1895.

The revised estimates for this section are as follows:

Glacial drift, 49,788 cubic yards at 30¼c	$ 15,060.87
Solid rock, 1,001,183 cubic yards at 79¼c	793,437.53
Core in levee, force account work	17,907.10
Levee emergency work	14,113.82
Total cost	$840,519 32
Amount earned to January 1, 1895	559,657.32
Amount earned to January 1, 1896	838,369.26

Figures 205 and 206 are respectively the location map and profile of sections 11 and 12. The small amount (from 1 to 3 feet) of loose earth overlying the rock surface was removed by shovelers, wheelbarrows, teams and wheel scrapers, and some of the rock from the upper cuts was removed by dump-cars and cable inclines, but the most of it was removed by three Brown hoisting and conveying cantilevers. These machines were not used by the contractors themselves, but their builders retained ownership and hoisted and dumped the rock for a fixed price of 15 cents per yard.

As is seen by the map, Fig. 205, considerable river diversion channel was required for this section and the accompanying levees were built with spoil from the new bed of the Desplaines, and with what was taken from the main channel by other methods than the cantilever conveyors. The methods of rock cutting and blasting were similar to those previously described. The total equipment of the two parts of this section included three cantilevers,* six channelers, 15 Ingersoll-Sergeant and two Rand drills, one 18x30-inch duplex Rand compressor operated by two 100 horse-power Kewanee boilers, one 10-inch, four 6-inch and two 4-inch Worthington pumps for draining the pit, one 8-inch Heald & Cisco centrifugal pump for boiler feed and water supply storage.

The method of excavating with stopes and cable hoists employed one Copeland & Bacon engine with 40 horse-power boiler and one No. 35 Lidgerwood single-drum hoisting engine, 28 teams, 46 dump carts and 26 2-yard, 30-inch-gauge Corey dump cars, and removed the rock to a maximum depth of 12 feet. With the three cantilevers, about 37,000 cubic yards a month were removed by an average force of 180 men working a day turn only. About 45 men were worked on each force besides those operating the conveyer. A little more than 1¼ tons of coal was burned for each conveyor in 10 hours, and the average amount of rock handled was nearly 500 cubic yards, about 11¼ yards per man. Four 3½-inch cylinder Ingersoll-Sergeant drills do all bench work, and in from five to six hours drill 16 12-foot holes in each bench.

Figure 210 shows the base of the tower of one of the cantilever conveyers on section 11, and shows the arm which overhangs the spoil bank with a bucket suspended from it that has just been traversed out and dumped, the load being instantaneously photographed in mid air.

* Preceding parts have been published in the issues of April 4, 11, 18 and 25; May 2, 9, 16 and 23; July 4 and 18; August 1, 15 and 22; September 5 and 19; October 3 and 31; November 21 and 28; December 19 and 26, 1896; February 13, March 13, April 17, July 17, August 14, September 11 and October 16.

* One Lidgerwood 700-foot span cableway was at first used on this section, but was afterward transferred to section 6.

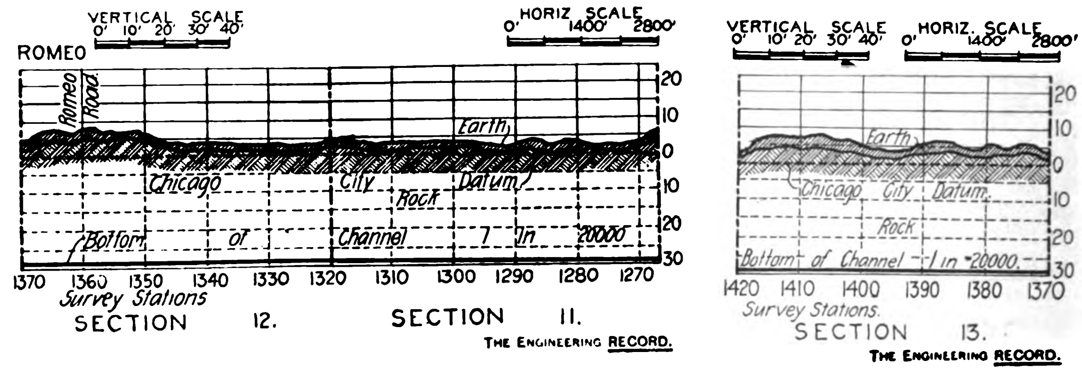
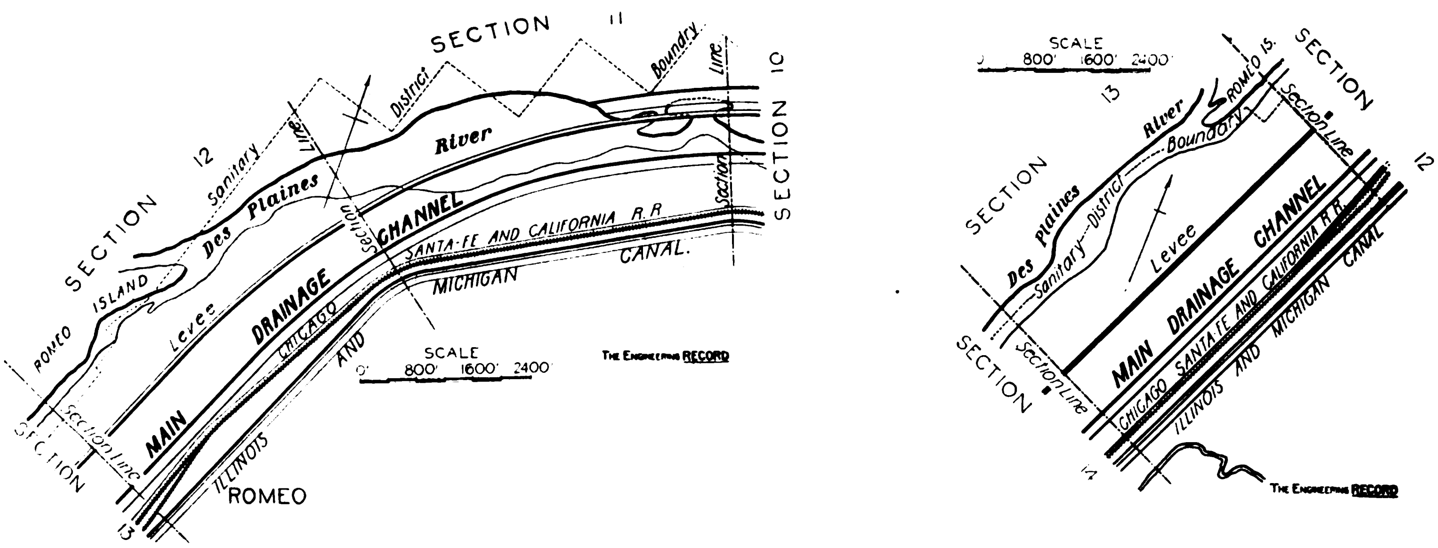


FIG. 206 and 213.—Profile of Sections 11, 12 and 13 showing exact lines of original surface and of the canal bottom and showing approximate location and amount of rock indicated by the original borings.



FIGS. 205 and 212.—Preliminary location maps of Sections 11, 12 and 13.

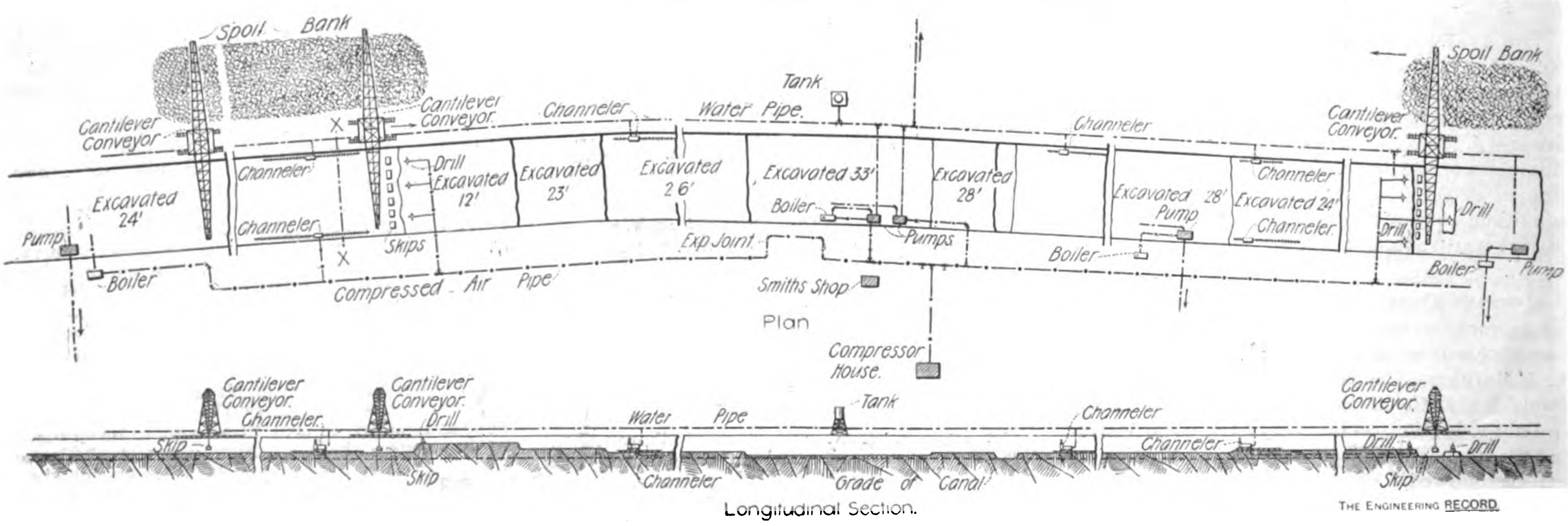


FIGURE 201.—Diagram to approximate transverse scale showing location of plant, arrangement of tracks, position and arrangement of excavation, etc., and a corresponding longitudinal sectional view to approximate vertical scale showing amount of excavation and position of working faces on Section 11.

THE CHICAGO DRAINAGE CANAL.

Section 12 is 5,000 feet long, beginning at survey station 1,320 and extending to station 1,370. It has a small portion of curved alignment at the east end and the rest is on a tangent, as shown by Fig. 205. The contract was let in July, 1892, to Mason, Hoge & Co., and has been carried on by Mason, Hoge and King, and Dandridge and Hangan, members of the principal firm. The work was practically completed in 1895.

The revised estimates on this section are as follows:

Glacial drift, 41,733 cubic yards at 30¼c	$12,626.05
Solid rock, 1,000,500 cubic yards at 79¼c	792,896.25
Retaining walls, 10,000 cubic yards at $3.50	35,000.00
Core in levee, force account	7,541.87
Deepening river channel	8,912.88
Total cost	$857,007.05
Amount earned to January 1, 1895	521,655.55
Amount earned to January 1, 1896	852,523.06

Some spoil was excavated from the old bed of the Desplaines River, and that, together with the small amount of loose earth (from 1 to 2 feet deep) over the rock on this section, and some of the first cut of the rock excavation, was used in building the levee shown in Fig. 205. The excavation was begun with carts, teams and dump-cars which were hauled out of the pit by two inclined plane hoists of the system shown in Fig. 179, page 225, such as was used on section 8, but these had been superseded by three Brown conveyor cantilevers, shown in Fig. 208, which took the rock already loaded into skips, hoisted it and dumped it on the spoil bank, upon a sub-contract for 15 cents per cubic yard. The rock was excavated by the same system of channeling and blasting in successive stopes, as has been already described in these articles. Seven Ingersoll-Sergeant drills worked two benches, three drills on each bench, and one drill block holing out in 18 12-foot holes across the bench, or 36 12-foot holes in all. This work was done with 6 3¼-inch drills in from six to eight hours. The holes are spaced 8 feet back from the face, 350 pounds of powder being used to make this blast on each

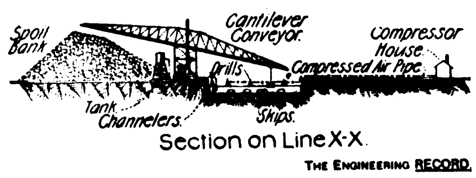


FIG. 209.—Cross sectional elevation of canal corresponding to Sections 11 and 12.

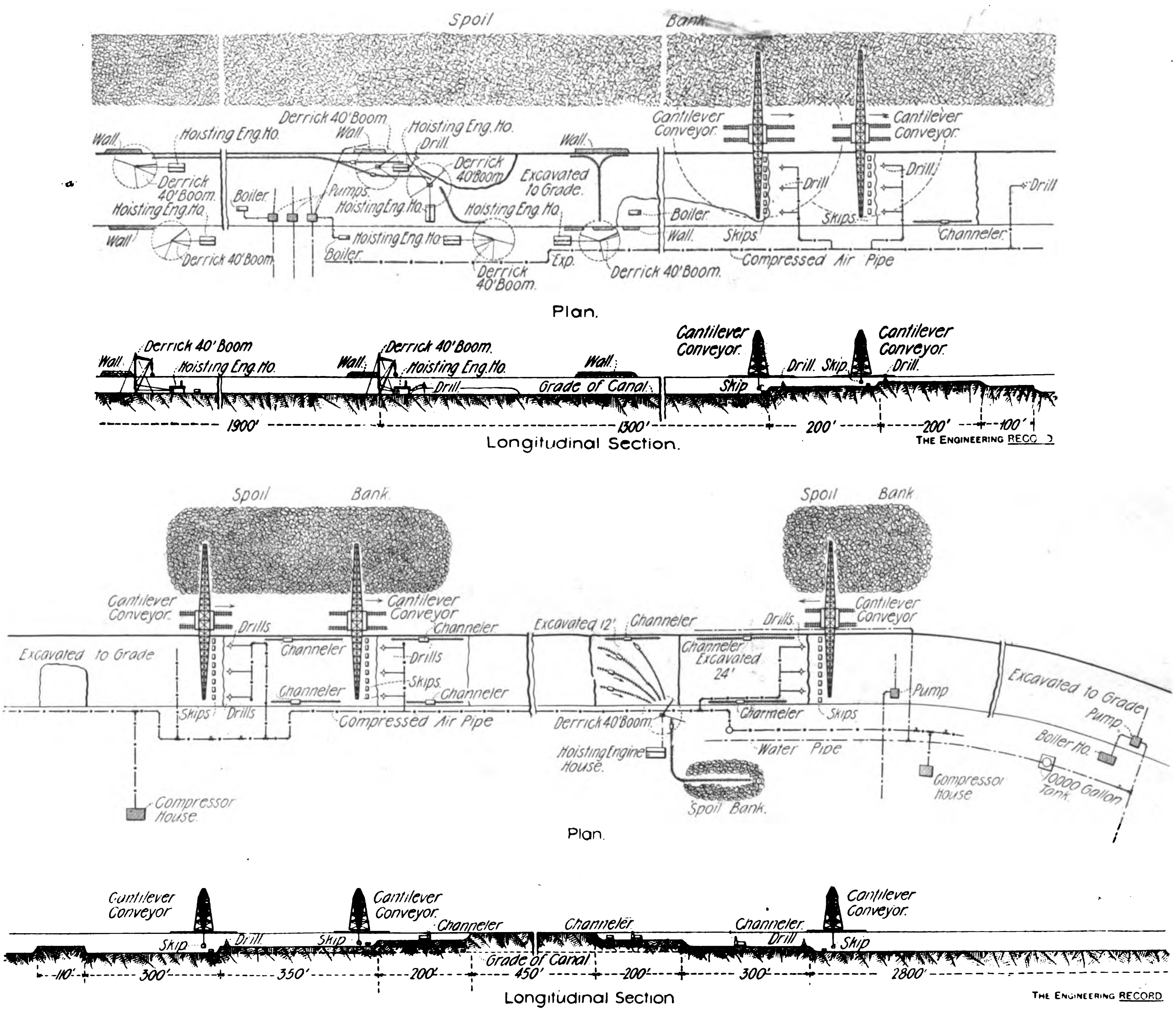
breast. The average output of rock per month broken on this with the above drills was 25,000 to 40,000 cubic yards. Forty per cent. dynamite, Hercules brand, was ordinarily used, but Judson powder was found more satisfactory for holes in the occasional pockets of glacial drift. The drills were operated by compressed air furnished by an 18x30-inch Corliss duplex Ingersoll compressor.

Three men were required to operate each cantilever, and 45 men were employed loading the buckets. They removed an average of 300 buckets to each cantilever per day; 1¼ yards per bucket; averaging 13,000 to 14,000 yards per month each. Three 10x6-inch Worthington pumps were installed for drainage, and also provided the water supply from what was raised from the pit, part of it being pumped into tanks and pipes along the south berme of the canal. About 125 men were employed, working days only. The records for the steam inclines used in the first cut show the following output:

July, 1893—Incline No. 1, 2 breasts, 10,110 cu. yds. in 25 shifts, 10 hours.
July, 1893—Incline No. 2, 2 breasts, 10,560 cu. yds. in 25 shifts 10 hours.
August, 1893—Incline No. 1, 2 breasts, 14,287 cu. yds. in 27 shifts 10 hours.
August, 1893—Incline No. 2, 2 breasts, 13,408 cu. yds. in 27 shifts 10 hours.
September, 1893—Incline No. 2, 2 breasts, 14,979 cu. yds. in 26 shifs 10 hours.
October, 1893—Incline No. 2, 2 breasts, 10,290 cu. yds. in 25 shifts 10 hours.

The average shown above for the month of September is 576 yards or 360 cars for 10 hours. The average haul in the pit for incline No. 1 was 250 feet, and for incline No. 2, 300 feet, and the cars averaged $1\frac{6}{10}$ yards "place rock."

The contract for section 13 was let to Mason, Hoge & Co., in July, 1892, and the work was superintended and executed under their name and responsibility by Woolfolk, Johnson & Comer, and Dandridge & Hangan, who were associated with them for them for that purpose. This section is 5,000 feet long, extending from survey station 1370 to 1420. The work consisted almost entirely of solid rock excavation and building



FIGS. 214 and 208.—Diagram to approximate transverse scale showing location of plant, arrangement of tracks, position and arrangement of excavation on Sections 12 and 13 and a corresponding longitudinal sectional view to approximate vertical scale showing amount of excavation and position of working faces.

THE CHICAGO DRAINAGE CANAL.

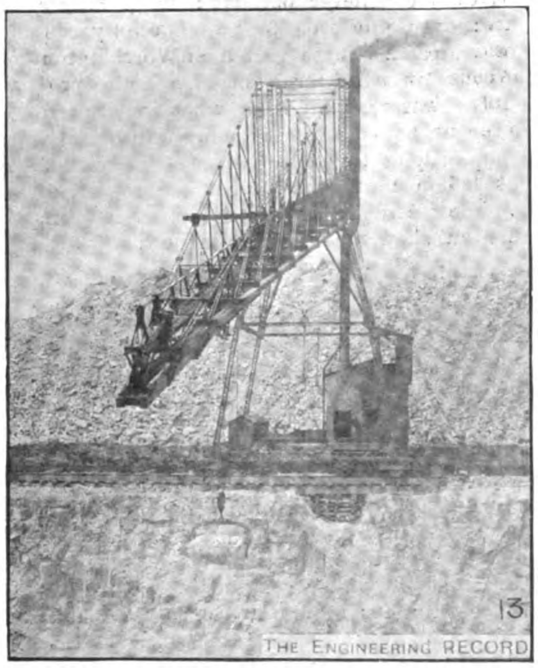


FIG. 216.—Front view of cantilever conveyor and bucket suspended over canal. Section 13.

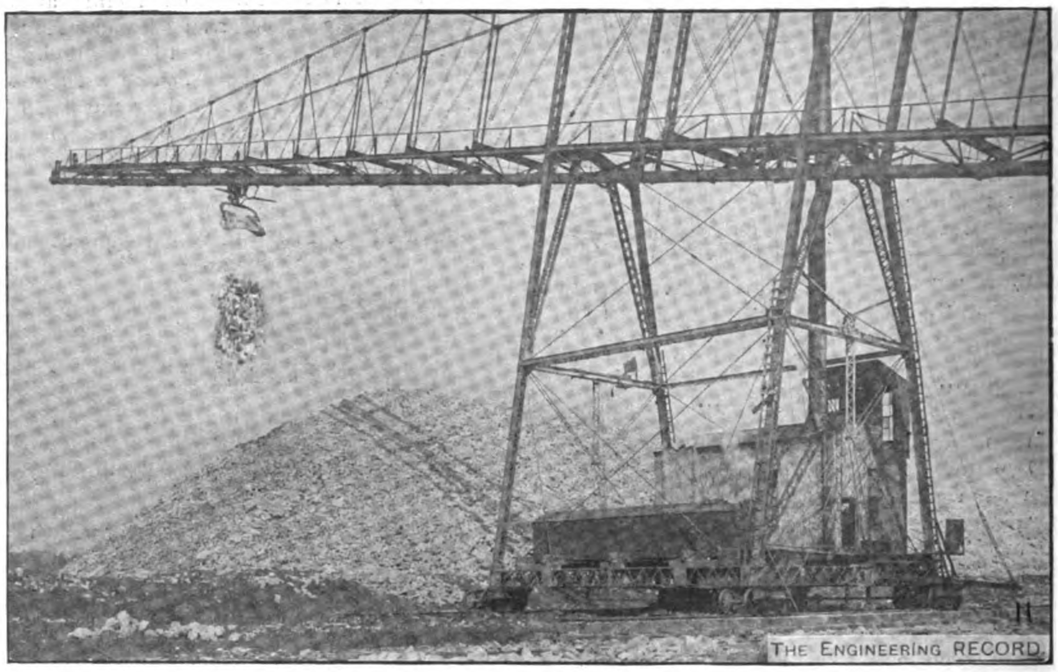


FIG. 210.—Cantilever conveyor dumping load of stone.

retaining walls, and was steadily persecuted and completed.

The revised estimates on this section are as follows:

Glacial drift, 35,000 cubic yards at 26c	$ 9,100.00
Solid rock, 1,053,700 cubic yards at 74¾c	787,640.75
Retaining walls, 20,000 cubic yards at $3.50c	70,000.00
Total cost	$866,740.75
Amount earned to January 1, 1895	661,621.47
Amount earned to January 1, 1896	816,573.72

Figures 212 and 213 are respectively the location map and the profile of section 13. The foot or so of dirt that overlaid the surface of the rock was removed by wheel scrapers and shovelers and wagons, and the first 12 feet of rock excavated was removed by 50 special dump-cars, built by the contractors and hauled out by their Lidgerwood engines operating the hoist cables on inclines similar to those used on sections 8 to 12, and illustrated in Fig. 215. The rock cutting was done by four Sullivan channelers, four Ingersoll drills, and four Rand drills operated by compressed air furnished by an 18x30-inch Rand compressor. From 19 to 23 holes were drilled in a row about 8 feet back from the face and charged with 25 to 30 sticks of 40 per cent. dynamite. About 250 men were employed days only, and the output was about 500 yards of rock. One 10-inch (discharge) and two 6-inch pumps were required for drainage, and two 4-inch and one 3-inch pumps, all Worthington, were required for boiler feed and for the water supply which was drawn from the pit and distributed through a 3-

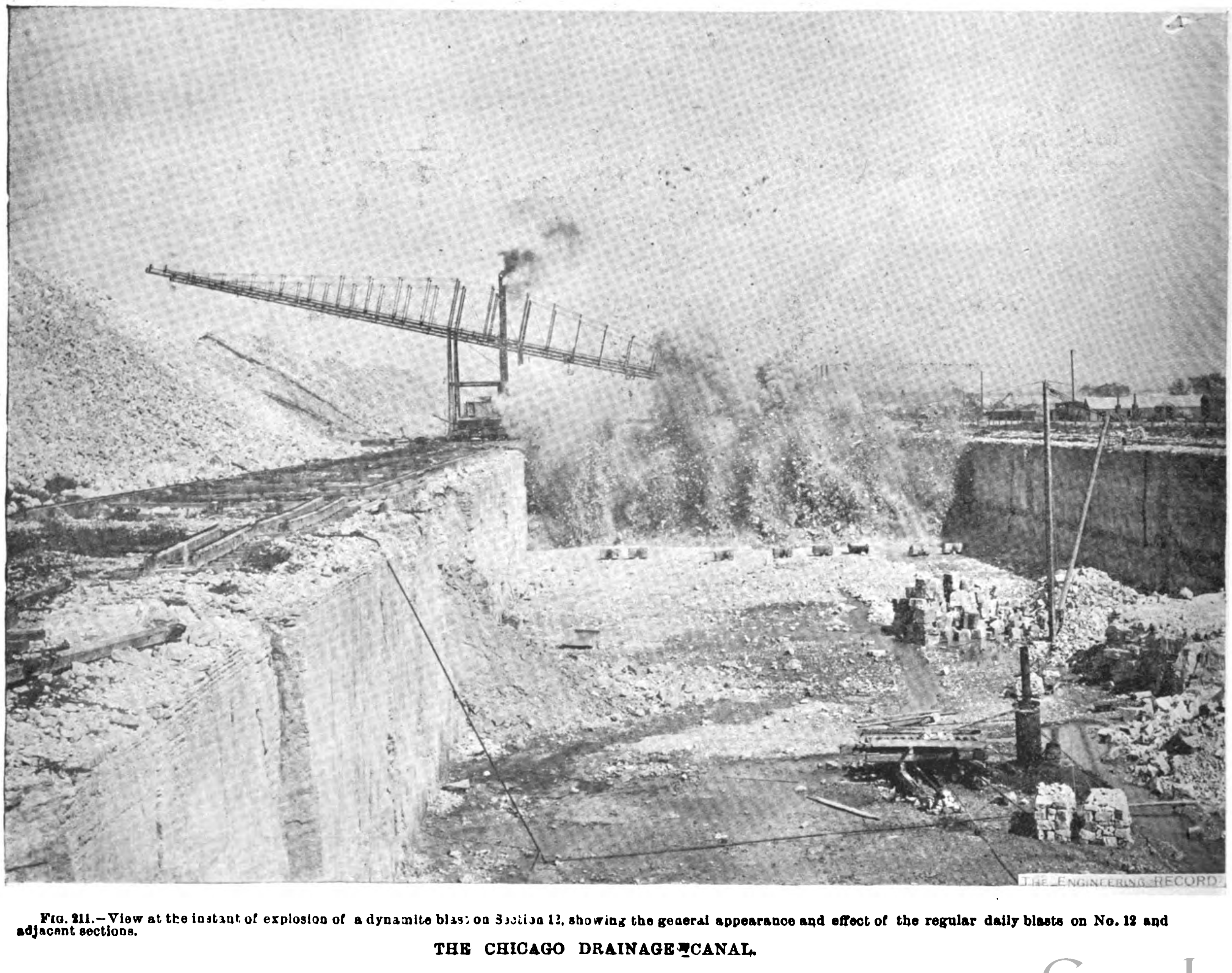


FIG. 211.—View at the instant of explosion of a dynamite blast on Section 12, showing the general appearance and effect of the regular daily blasts on No. 12 and adjacent sections.

THE CHICAGO DRAINAGE CANAL.

inch pipe laid on the north berme. When the sketches for Fig. 214 were made two quarries were being worked in the pit bottom for stone for the retaining walls that were required as indicated at several places to surface up cavities left by pockets of glacial drift. Two Brown cantilevers were used throughout the work to remove the rock spoil and a part of the time four were installed there. One of the cantilevers was destroyed through carelessness during a heavy wind storm in April, 1893, after having operated but a short time, and at the expense of several lives. The machine was mounted on a track, along which it traveled parallel to the axis of the channel by its own motive power. At the time of the storm it was not properly fastened to the track, with the result that the wind set it in motion until it had traveled to the end of the track, which point being reached, the machine overturned and was completely wrecked.

Figure 216 is an end or front view of the Brown cantilever with bucket suspended over the canal.

[TO BE CONTINUED.]

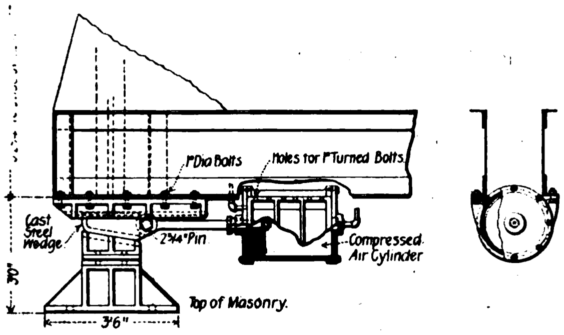
SWING BRIDGES ON THE CHICAGO DRAINAGE CANAL.

PART II.—DIAGRAMS OF 368-FEET 3¼-INCH AND 322-FEET 9½-INCH SPANS; DESCRIPTIONS OF SUBSTRUCTURES AND SUPERSTRUCTURES AND DETAILS OF END LIFTING AND LOCKING APPARATUS FOR 474-FOOT 3⅜-INCH SPAN.*

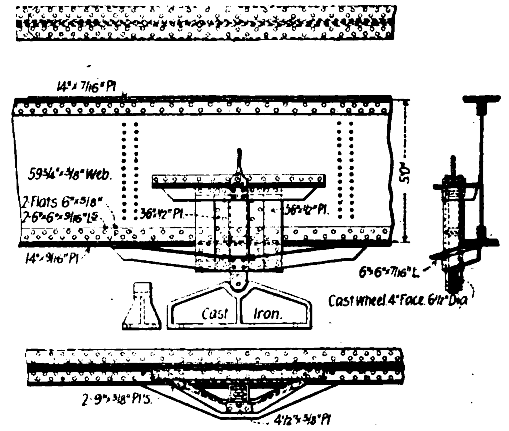
THE specifications for the substructures of all the Canal railroad bridges are uniform and conform to standard masonry and pile work requirements, except in some special features, which are chiefly included in the following excerpts.

Among the bridges are four, with sites as follows: Chicago, Madison & Northern Railroad bridge near east end of Contract Section N, Atchison, Topeka & Santa Fe Railway bridge at west end of Contract Section N, Atchison, Topeka & Santa Fe Railway bridge near east end of Contract Section G, Chicago & Calumet Terminal Railway bridge near west end of Contract Section E.

*Part I.—Diagrams and Loading of the Chicago & Calumet Terminal Railway and of the Chicago, Madison & Northern Railroad spans was published October 2.



Detail of End Lift
FIG.6



Detail of End Floor-Beams.
FIG.7

"All stone must be quarried without the excessive use of explosives, and shall be taken out whenever practicable by the use of plug and feather. It shall be quarried in time to season against frost before being used.

"The best Portland and natural cements shall be used on this work. The weight per cubic foot of Portland cement shall be not less than 100 pounds and for natural cement shall be not less than 67 pounds. The development of tensile strength for Portland cement shall be not less than 400 pounds per square inch and for natural cement not less than 100 pounds per square inch, after being exposed one day in air and six days in water. The sand used shall be coarse, clean and sharp, free from all clay, loam or gravel, and shall be well screened and of a quality approved by the Chief Engineer. When Portland cement mortar is used for beds and joints it shall be mixed in proportion of one part of cement to three parts of sand. When mortar is used for grout it shall be mixed one part cement and two parts sand. When it is used for pointing, one part cement and one part sand.

"Piles are to be of white or burr oak, sound and straight, not less than 14 inches at the butt and not less than 9 inches at the small end, with a uniform taper. Timber used in foundations shall be white oak, sound, straight and free from wind shakes. Foundation timber, resting upon foundation piles, shall be placed and secured by seven-eighths of an inch diameter drift bolts, 12x12 inch white oak caps.

"Concrete shall be made in the proportion of one part of cement, three parts of sand and six parts of broken stone. It shall be mixed by machinery, if so directed by the Engineer, or if mixed by hand it shall be done upon a suitable platform. Care must be taken to first thoroughly mix the dry cement and sand; after which stone shall be added, together with a proper amount of water, all to be thoroughly mixed; water to be applied by a sprinkling pot. On being placed, the concrete shall have a wetness such as to permit quaking or mobility likened to liver. The stone for the concrete shall be broken into angular pieces of a size small enough to pass through a ring 2 inches in diameter, and be entirely free from dust, sand, dirt and any foreign substance. The stone must be thoroughly drenched with clear water before mixing with the mortar. The concrete is to be deposited in layers not exceeding 6 inches in thickness and to be thoroughly tamped or rammed. Concrete shall be made in the same manner as specified above for Portland cement concrete, except that the proportion shall be one part cement, two and one-half parts sand and five parts of broken stone.

"Masonry shall not be laid in freezing weather without written permission of the Chief Engineer. Any masonry so laid in freezing weather shall have joints raked out and pointed in the spring at the expense of the contractor. Should masonry be laid in freezing weather, the stone shall be sufficiently warmed to remove all ice from surface, and the mortar mixed with brine, made by dissolving one pound of salt to 18 gallons of water when the temperature is 32° Fahr., adding one ounce of salt for each degree the temperature is below 32 degrees.

"It is especially understood and agreed that eight hours shall constitute a day's work, and no workman shall be employed or required to work more than eight hours out of any 24 hours, and no work in excess of that time shall be allowed.

"In the event of any violation of the above eight-hour provision it is agreed hereby that the said district shall, and that it is duly authorized to retain from any money due or to become due at any time from it to the second party, as liquidated damages, the sum of $5 per hour for each hour that any employee shall be required to work in excess of eight hours per day, pursuant to the terms and conditions of the ordinance adopted June 23, 1897, attached hereto."

All of these bridges cross the Canal obliquely to its axis, and their masonry is similar to that shown in Fig. 4, which shows the elevation and plan of the 368-foot 3¼-inch double track span of the A., T. & S. F. R. R. crossing. Figure 5 shows the outline of the 322-foot 9½-inch span of the same road, and the truss and masonry diagrams of the 321-foot 7¼-inch roadway bridge at Kedzie Avenue are essentially similar to Fig. 4. Some special features are introduced in the design and operation of the operating machinery which, with characteristic details and typical connections of truss members, will be illustrated in this and succeeding issues of the RECORD.

Figures 6 and 7 show the end lifting and locking mechanism of the 474-foot 3⅜-inch double-track draw span of the Chicago, Madison & Northern Railroad Company's bridge on Section N, a diagram of which was shown by Fig. 3, page 378.

Figure 6 shows one of the four end pedestals that take up the abutment reactions through simple steel wedges that are simultaneously operated directly by and attached to the piston rods of individual pneumatic cylinders commanded from the operator's platform.

Figure 7 shows part of the middle of one end floor beam and the arrangement of the locking bar and its saddle.

(TO BE CONTINUED.)

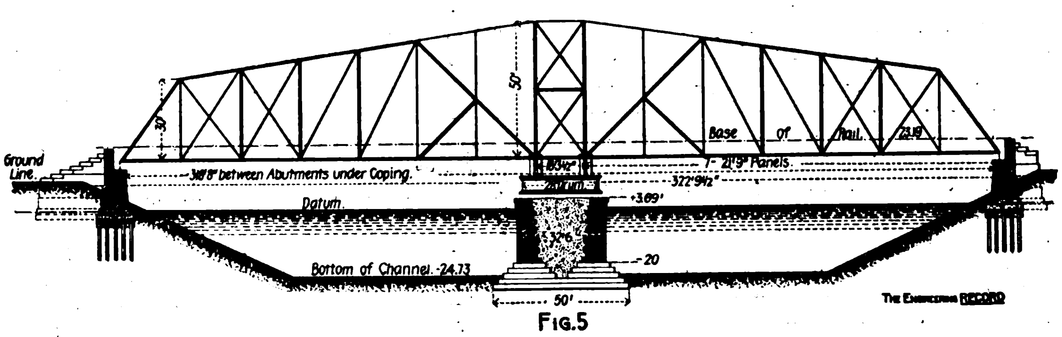


FIG.5

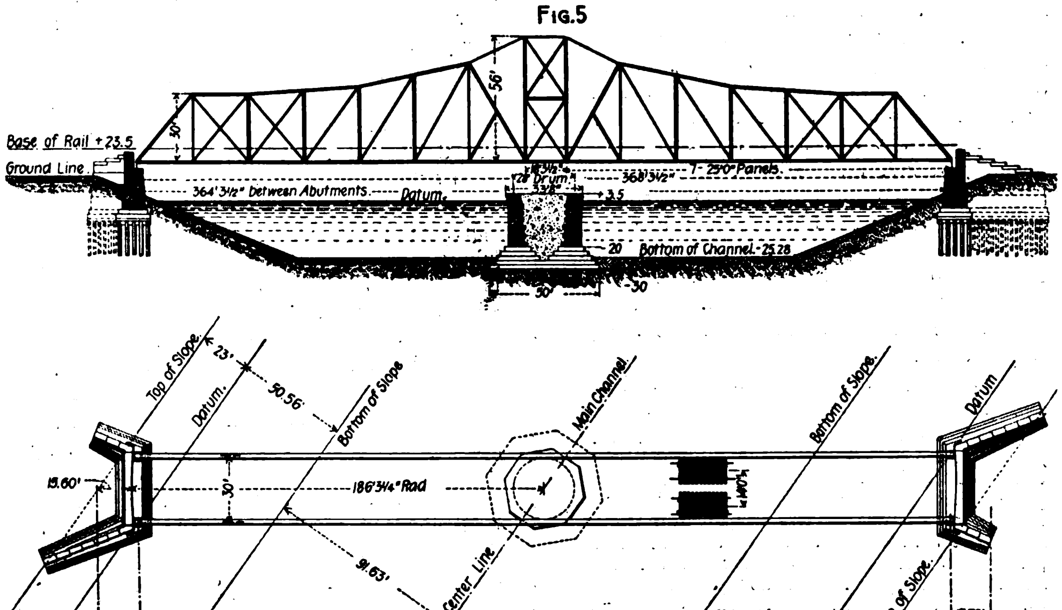


FIG.4

SWING BRIDGES ON THE CHICAGO DRAINAGE CANAL.