ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

Vol. XXXIX., No. 21.

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FIVE FIRST-CLASS ARMORED CRUISERS, of 11,500 tons each, and at least 20 knots speed, are provided for in a bill just introduced into Congress by Representative Pearce, of Missouri. The bill fixes a maximum price of $4,000,000 each for the cruisers, and further provides for 13 additional torpedo boat destroyers, costing not more than $650,000 each, and ten torpedo boats, costing not more than $200,000 each. The displacement of the latter boats would be 400 and 150 tons respectively, and the speed is to be "the highest possible." The total bill would require an expenditure of over $30,000,000.

THE FOUR HARBOR-DEFENCE MONITORS recently authorized by Congress will be novel in type and efficient for the service intended. As briefly outlined the plans call for only 2,500 tons displacement; a mean draft of 11 ft.; speed of 12 knots, with 3,500 I. HP.; a single turret with 12 ins. of Harveyized steel and 11 ins. of steel on the sides; two 10-in. or possibly 12-in. guns, a battery of 4-in. rapid-fire guns and a good secondary battery. The cost is limited to $1,250,000 each. Comparing these with the monitors now in service, the "Puritan" has a displacement of 6,060 tons, the "Monterey," 4,084 tons and the "Miantonomoh" 3,990 tons. But these monitors have two steel barbette turrets each and carry four 10-in. or 12-in. guns apiece. The "Puritan" draws 18 ft. of water and the other two 14 ft. and 14 ft. 6 ins.; the "Puritan" has a speed of 12.4 knots; the "Monterey," 13.6 knots, and the "Miantonomoh" 10.5 knots. But the armor of the older boats is inferior, as the "Puritan" has 8 ins. on the turrets, with 6, 10 and 14 ins. on the sides and 14 ins. on the barbette; the "Monterey" is a little lighter still in armor, and the "Miantonomoh" has 11½ ins. on the turrets and 7 ins. on the sides. The new monitors are especially designed for harbor work; and with very light draft, fair speed, a freeboard of only 20 ins. and the armor and guns of a battleship, they should render a very good account of themselves against any form of attack.

THE BATTLESHIPS "KEARSARGE" AND "KENTUCKY" may be completed by Nov. 1 next. At least, the Newport News Ship Building & Dry Dock Co. is using every effort to finish them by that time. The "Kearsarge" has received her six boilers, weighing 90 tons each, and those of the "Kentucky" will be at once put in place. No night work is yet being done, but that may be ordered by the Navy Department. The battle ship "Alabama," at the Cramps' yard in Philadelphia, is also being pushed, with the idea of finishing it about the same time as the other two.

THE CHIEF OF THE BUREAU OF YARDS AND Docks, Commodore Mordecai T. Endicott, C. E., U. S. N., was tendered a dinner at the Engineers' Club, in this city, on May 21. About 75 guests were present, including prominent civil engineers, naval architects and naval officers. The occasion of the dinner was the celebration of the appointment of a civil engineer, in the person of Mr. Endicott, as the head of this important bureau of the U. S. Navy Department, for the first time in its history. All previous Chiefs of this Bureau had been selected from among the line officers of the Navy. Speeches were made by Commodore Endicott, Commodore Geo. W. Melville, U. S. N., Chief of the Bureau of Steam Engineering; Chief Engineer Chas. H. Loring, U. S. N.; Prof. Palmer C. Ricketts, and Messrs. Mendes Cohen, Henry G. Prout and O. F. Nichols, Members of the American Society of Civil Engineers.

THE THREE DYNAMITE GUNS, mounted at Fort Hancock, Sandy Hook, N. J., about four years ago, have been perfected by careful experiment and are now regarded as most formidable war engines. They have an effective and very accurate range of 5,000 yds., and the 1,000-lb. projectile carries 500 lbs. of nitro-gelatine. They are discharged by pneumatic power.

AN INCREASE IN THE CORPS OF ENGINEERS, U. S. A., is contemplated in a draft of a bill and a communication sent by Secretary of War Alger to the U. S. Senate. The increase is to be gradual, and the bill provides as follows: One Chief of Engineers, with rank of Brigadier General; seven Colonels, 14 Lieutenant Colonels, 28 Majors, 35 Captains, 30 First Lieutenants, 12 Second Lieutenants, and a battalion of engineers. All promotions would be by seniority. According to the Army List of 1896, the last available, there were then—one Chief of Engineers, six Colonels, 12 Lieutenant Colonels, 24 Majors, 30 Captains, 26 First Lieutenants, 10 Second Lieutenants and three "additional" Second Lieutenants.

THE CRAMP SHIPBUILDING CO., of Philadelphia, Pa., is reported as having made a business alliance with the wealthy English shipbuilding firm of Vickers Sons & Maxim, of Barrow-in-Furness. The scheme proposes the increase of the capital stock from $5,000,000 to $10,000,000, or more, and an enormous increase of the plant at Philadelphia with the money paid in by the English stockholders. The Cramps now own about 700 acres of land adjacent to their present yard, and this will be utilized in the new plant. The report is said to have been denied by Mr. Chas. H. Cramp, but in terms which left a possibility that some part of the report was true.

THE COMMERCE OF SAULT STE. MARIE CANAL, in the 240 days of navigation in 1897, amounted to 18,954,000 tons of freight, valued at $218,000,000. This is an increase over 1896 of 11% in tonnage and 25% in value. The average charge in 1897 for carrying one ton of freight one mile on Lake Superior routes was .83 mill; it was .99 mill in 1896. In other words, one ton of lake freight last year was carried 12 miles for one cent; wheat was carried 1,000 miles for 1¾ cts. per bushel; coal was carried the same distance for 20 cts. per ton; and iron ore, from the docks at Duluth to Lake Erie ports, for 55 cts. per gross ton. Even with these excessively low rates the aggregate freights earned by vessels passing through the "Soo" canal amounted to over $13,000,000 for the season on voyages averaging 841 miles. This reduction in freight charges follows the tendency to increase the power and capacity of the lake vessels. In 1896 the largest lake vessels carried 5,000 tons; in 1897 no less than eight boats passing the canal carried over 6,000 tons, and there were in addition 28 other vessels plying between Lake Superior and lower lake ports that have a capacity of 5,500 tons each. During this year two or three boats of 7,000 tons capacity will be added to the fleet.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Vandalia Line on May 21, about 2½ miles east of Collinsville, Ill. A special train carrying several railway officials ran into the caboose of a work-train. Four men on the work-train were killed, and 20 were injured.

AN ACCIDENT on the Chattanooga, Rome & Southern Ry., near Rossville, Tenn., on May 21, resulted in the death of one soldier, the serious injury of two others, and the slight injury of several. A train containing the 1st Missouri Volunteer Infantry was standing on the main track between Rossville and the camp at Chickamauga when the regular south-bound passenger train crashed into its rear with the casualties mentioned.

A TORNADO swept over Michigan, Wisconsin, Illinois and Iowa on May 18, and is reported to have killed 60 persons and injured a much larger number.

A DOCK FAILURE occurred on May 15 at the works of the American Sugar Refinery Co., on the East River, New York city. The dock was a two-story structure extending out into the river about 400 ft. Both stories were usually filled with bags of raw sugar waiting to be elevated to the refinery. The break occurred near the outer end and included a section of the dock 50 x 100 ft. The accident is attributed by some to the pier of the new East River Bridge near by, which it is claimed altered the tidal current, thus causing erosion around the piles which supported the pier.

THE NEW ALLEGHENY RIVER SLACKWATER SYSTEM, for its proper exploitation, calls either for a new type of boat, or the raising of a number of bridges, according to the members of the Pittsburg Coal Exchange. The Union bridge has a clearance of 35 ft.; the Sixth St. bridge, 33 ft.; and other bridges on the Allegheny River, from 33 to 55 ft. On the Monongahela River, the least clear space under the bridges is about 53 ft. These bridges were all built before slack water navigation was contemplated, and it is now proposed to build the tugs used with low cabins and very low stacks, so as to enable them to pass under the bridges. In 1897 the freight movement on the Allegheny River was 436,668 tons, as reported by Majors Powell and Hoxie, Engineer Corps, U. S. A. The local harbor trade in the Allegheny, at the same time, was 1,701,653 tons. The increase in trade on the river over 1892 is 23% and 73% in the harbor.

NEW YORK CITY'S DEBT has now been further reduced by the latest decision of its Corporation Counsel, according to which the city was several million dollars within its constitutional debt limit on Jan. 1, when its consolidation with the surrounding municipalities took effect. This removes the question of validity from the contracts executed near the close of Mayor Strong's administration, and means the energetic prosecution of work upon the East River Bridge, the new city school buildings and other works under contract, and probably the letting of new contracts for other needed public improvements.

THE FRANCHISES OF GREATER NEW YORK are outlined and discussed in an interesting manner in "The Yale Review" for February, by Mr. Max West, of Washington, D. C. The experience of this great city in franchise matters shows, for the most part, how franchises should not be disposed of. Ferry franchises have been in control of the city for more than two hundred years, the revenue from this source increasing from $258 in 1674, to $1,375 in 1771, and to $330,000 in 1896. The franchises are sold at public auction once in ten years, and though they are generally bid in by the same company, considerable revenues are secured even in such cases, because the authorities have the right to name an upset price. Street railway franchises are about the only other example of revenue-bearing franchises, but the sums they yield are insignificant compared with what they might and should be made to yield. The greater part of the article is devoted to the street railway franchises. The new charter seems to have annulled the provision of the Cantor act that all street railway franchises in the state should be sold to the highest bidder, but it limits the life of all franchises to 25 years, and provides, in the case of new franchises, for municipal ownership at their expiration, or for a renewal of the lease.

THREE NEW STREET RAILWAY COMPANIES, in New York city, are asking for authority to build from the State Railroad Commission. The North End Street Railway Co., with $5,000,000 capital, wishes to construct 13 miles of road from Manhattan Ave. and 116th St. to the northerly line of the city, with many branches. The Fort George & Eleventh Avenue Railway Co., with $10,000 capital, wants to build 1,500 ft. of road connecting Kingsbridge Road and 175th St. Both of the roads would be controlled by the Metropolitan Street Railway Co. The Kingsbridge Railway Co., a part of the Third Avenue system, with $1,000,000 capital, asks permission to build 8 miles of road from Manhattan St. and the Boulevard over the Harlem ship-canal bridge to Riverdale Ave. and the city line.

MUNICIPAL OWNERSHIP OF WATER-WORKS AT Denver, Colo., has been receiving the attention of the city officials for some time. On May 17 the Denver Union Water Co. offered to sell its works to the city for $9,000,000, of which $2,000,000 was to be paid in cash or 4% city bonds, and $7,000,000 was to be met by the city assuming that amount of 5% company bonds, issued after the recent consolidation of the two rival water companies. The Denver "Post" states that after the recent decision in the water rate case in favor of the city (on which we commented in our issues of Feb. 24 and March 3, 1898) the bonds of the company rose from 60 to 85 cts. on the dollar. A suit over the purity and pressure of the water furnished by the company is now pending.

GUTTA-PERCHA, says Dr. E. F. A. Obach in a lecture before the British Society of Arts, was first brought to Europe by the Tradescants, in 1656. In 1845 it was reintroduced from Singapore, and in 1847 Sir W. J. Hooker gave it a name; and in the same year E. W. von Siemens used it for an insulating material on a submarine telegraph cable. The original name was Isonandra gutta; now altered in England to Dichopsis gutta. The crude commercial gutta-percha contains from 1.0 to 27% of water, and from 1.8 to 22.3% of dirt. The genuine gutta-percha has a specific gravity of 0.9879, at 15° C.; begins to soften at 45.7° C.; is pliable at 65° C.; hardens in 8.6 minutes; has a tensile strength of 3,906 lbs. per sq. in.; and an elongation of 413%. Its electrical properties per "cube knot" are: Insulation at 75° F., second min. megohms, 5,484; inductive capacity, 0.0549 microfarads. In England the maximum consumption was 3,000 tons, used chiefly for electrical purposes, in 1881-82; by 1896 the consumption had fallen off to about 1,200 tons. The various submarine cables in use now contain about 24,000 tons of cleaned gutta-percha.

A NEW FIREPROOF FLOOR.

In most of the fireproof floors now on the market the strength is based upon the use of the arch principle, either by the adoption of a curved arch of concrete (usually reinforced by metal netting or ribs) or a flat arch built of blocks so shaped as to be keyed together. In either case there is an end thrust to be provided for.

A new form of floor now being introduced differs materially from any type of construction now in general use in that it is designed on the beam principle instead of the arch principle. The floor consists of fireproof beams or blocks whose ends rest upon steel beams of the floor framing, and the arrangement is such that these fireproof beams cannot be improperly placed, but must be set properly or not at all. The beams are made of "mackolite," a material which is already extensively used for fireproof partitions, column and beam protection, etc. The basis of the material (which is a German invention), is gypsum, which is calcined, ground, mixed with water and certain chemicals, and then poured into molds, being left for about 1½ hours to set, after which it is kiln-dried for four days.

The beams are rectangular at the ends, but the sides are recessed or paneled so as to form approximately an I-beam section, with web about 5 ins. thick and flanges about 2 ins. thick. The general appearance of the blocks and the method of laying are shown in Fig. 1, where the blocks are 10 ins. deep and 4 ft. long, while Fig. 2 shows a cross section of the block. As the process of manufacturing requires the web to be made thicker than is necessary for strength, the web is lightened by having cored holes extending longitudinally through it. The blocks are made in various lengths up to 5 ft., which is the maximum spacing for the steel floor beams in ordinary cases, and their depth is from 6 to 15 ins. The width is uniformly 9 ins., and diagonally opposite vertical corners of the block are rounded off, so that the block can be slipped between the floor beams and then swung round till it is square with these beams. The ends are so formed as to rest on the flanges of the steel beams, and to project above and below them. The part below the beam is dovetailed to hold the tiles which protect the bottom flange of the beam. These tiles are 4 ft. long, so that each one is held by several of the blocks, and they are held in place by the dovetailing, without any reliance on a mortar joint. In erection, as the blocks are placed in one panel, the flange tiles are fitted into the dovetail groove, the other side of the tiles being temporarily held by steel clips embracing the edge of the tile and the edge of the beam flange. When the blocks are being put in the next panel, their dovetailed edges fit over the tile, and the steel clips are pushed along out of the way as the work progresses. This is shown by Fig. 3.

As the ceiling formed by the bottom of the blocks is a smooth and even surface, considerably less plastering is claimed to be required than on the rough and irregular surface of a tile arch, and this amount is still further reduced by the fact that there is no camber. In tile arches, a certain camber is usually required, to allow for the settlement due to bad joints, and if this settlement does not occur the space so left must be filled up by the plasterer. The saving in plaster by the Mackolite construction is estimated at nearly 20%. The blocks develop no deflection until 80% of the load capacity is reached, so that there is no fear of cracking a plaster ceiling by deflection under load. No centering is required for erection, and as there is no end thrust there is no necessity for tie-rods to hold the floor beams together. Steel channels are set in the walls of the building or the brickwork may be coped out to carry the ends of the blocks in the outer panels of flooring. The weight is only 25 lbs. per sq. ft. for 10-in. blocks, which is considerably less than the average actual weight for clay tile, so that a lighter system of framing can be used. The blocks can be cut and sawed to length or shape, and where pipes, etc., pass through the floor, the blocks can be bored out neatly with augers. The cost of the construction is claimed to be from 10% to 15% less than that for tile arch floors. Above the mackolite floor is a filling of cinder concrete, in which are embedded the floor strips and the gas or other pipes, electric conduits, etc., as shown in Fig. 1.

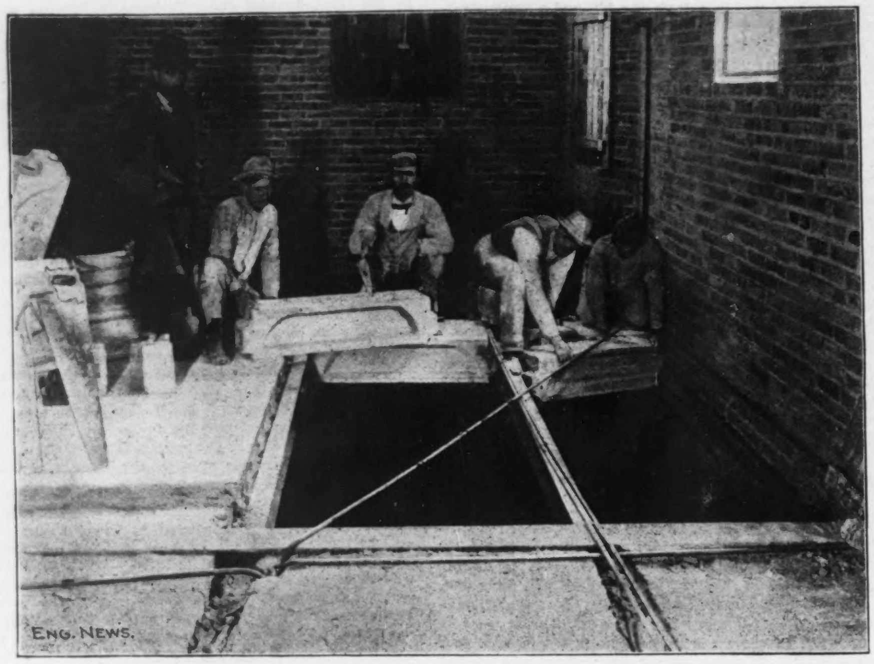


FIG. 1.—MACKOLITE FIREPROOF FLOOR BLOCKS.
Showing Method of Laying.

The following table gives the results of tests of different sizes of beams, the loads being applied at the center, and the figures being the averages for ten tests in each case:

Depth of block, ins.	Span, ft.	Weight of block per sq.ft., lbs.	Failed under center load, lbs.	Corresponding load per sq.ft., lbs.
10	4	25	1,150	575
10	4	30	1,650	825
10	5	25	1,145	460
10	5	30	1,500	600
7	4	22	1,000	500
7	4	20	905	450
7	4	18	800	400

While the use of "mackolite" for floors is quite new, this material has been in use for partitions, etc., for several years, and one of its special advantages is that in place of small tiles, large slabs are used, making a much more stable construction. The ordinary size is 48 × 12 × 3 ins., but the slabs can be cut to any shape or width for closures, etc. For column and beam protection, channel-shaped pieces may be used, while for round columns the pieces are of semi-cylindrical sections, having inside projections which bear against the column, forming hollow spaces which may be filled with grouting, etc., as shown in Fig. 4. The sections are held together by steel clips. Fig. 5 is a view of the interior of a ball-room, 50 × 30 ft., 14 ft. high, with floor, ceiling, walls, column protection, etc., all formed of mackolite blocks and slabs. This is in the new residence of Mr. Joseph Theurer, of Chicago, and the same material is used throughout the building, all plastering being done upon a surface of mackolite. Mr. Richard E. Schmidt is the architect for this building.

In further description of this material, it may be said that its conductivity of heat is only one-third that of clay tile. In a test made at Cornell University in 1892, two chambers were formed over a fire chamber or furnace, one being floored with ¾-in. slabs of mackolite, and the other with ¾-in. fire-clay tiles. A hot coke fire was maintained in the lower chamber, and after two hours the heat in the upper chamber floored with mackolite was only 184°, while in the adjoining chamber, floored with fire-clay, it was 600°. After five hours, the temperatures were 384° and 1,500°, respectively. The material will not resist abrasion, and is not recommended for use below the ground water-line unless plastered with Portland cement.

This material is manufactured by the Mackolite Fireproofing Co., 1303 Schiller Building, Chicago, and we are indebted to Mr. James B. Seager, General Manager of the company, for photographs and information made use of in this article.

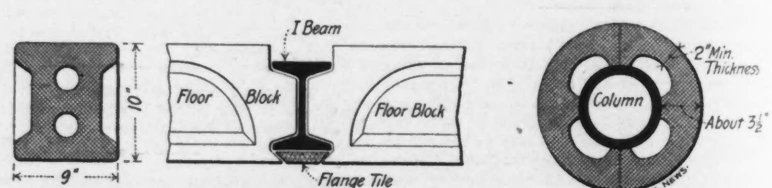


Fig. 2. Section of Floor Block. Fig. 3. Protection of Bottom of Floor Beam. Fig. 4. Column Protection.

FIGS. 2, 3 AND 4.—DETAILS OF MACKOLITE FIREPROOF CONSTRUCTION.

SPECIAL STRUCTURAL FEATURES OF THE 550-FT. ARCH BRIDGE AT NIAGARA FALLS, N. Y.

In our issues of Aug. 6, 1896, and April 22, 1897, we described quite fully the construction and design of the great 550-ft. steel arch bridge built to replace the old railway suspension bridge erected by John A. Roebling, in 1855, to carry the Grand Trunk Ry. across the gorge of the Niagara River, about two miles below the falls. Full details of this arch are given in a paper read before the American Society of Civil Engineers, on May 18, 1898, by Mr. R. S. Buck, M. Am. Soc. C. E., Engineer in Charge of Construction, and from this paper and the discussion which followed it we abstract some of the more important particulars which were not mentioned in our previous articles. The illustrations have also been reproduced from the "Proceedings" of the society for April, 1898, where the full text of Mr. Buck's paper will be found by those who wish to obtain it.

Skew Backs.—The construction of the end bearings or skew backs is shown by Fig. 1. Each bearing, of which there are four, consists of two steel castings, one of which is bolted rigidly to the

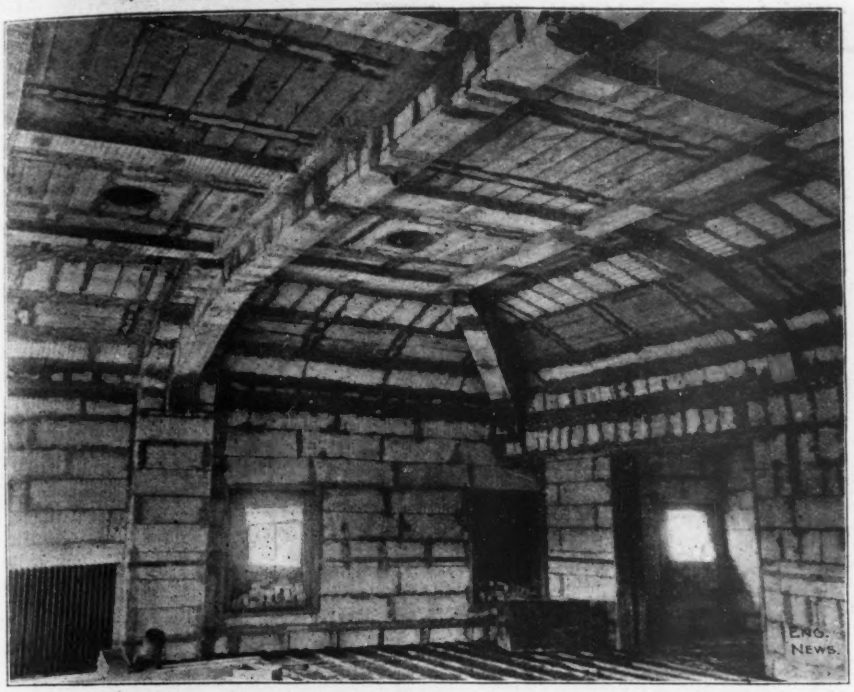


FIG. 5.—INTERIOR OF A BALLROOM WITH MACKOLITE FLOOR, CEILING, PARTITIONS AND SHEATHING.

masonry and has a concave cylindrical top surface, and the other of which is attached to the end of the arch rib and has a convex bottom surface fitting into the concave top surface of the first casting. Between the two castings is a nest of 45 segmental rollers set radially with respect

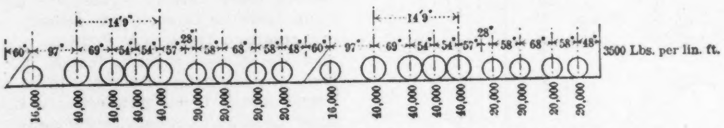


FIG. 3.—DIAGRAM OF TEST LOAD APPLIED TO EACH TRACK OF NIAGARA ARCH BRIDGE.

to the center of movement at A. The axis of the concave and convex bearing surfaces is also at A, and is perpendicular to the vertical axial plane of the bridge. The arch ribs proper being inclined toward each other and the end bearings being set straight necessitated a double bevel bearing where the two meet. This double bevel face is shown in Fig. 1, and there are two only in each arch rib, all the other rib joints being made with single bevels. This form of bearing was adopted to avoid the use of an excessively large pin, with which, it was thought, movement was rather doubtful of realization.

In placing the rollers the outside plugs b, Fig. 1, were inserted temporarily to hold them in their correct radial position and render them fixed. At the top the rollers almost touch each other, and in the wider spaces at the bottom are 5-16-in. square bars to cause contact and restrict movement should there be any tendency to overturn. The bars tap-bolted on both the upper and lower castings are further safeguards against undue movement. With this construction the rollers can move either way only a limited distance without binding, and as the movement caused by moving load and temperature is scarcely appreciable, there is little danger of the limit being reached. After the first panel of the arch was completed, connected with the anchorage and swung back to correct position for proceeding with the erection, the check plugs were removed and the rollers freed. The center plugs and the guide bars remained permanently.

The bearing on the rollers, with the maximum load on the bridge, is 2,200 lbs. per lin. in. of roller, assuming the pressure to be uniform on all of the rollers. The upper and lower castings were cast each in one piece. The ¾-in. plates on the bottom of the lower castings were intended as a precaution against any possible rupture of the castings. The manufacture of the bottom castings gave considerable trouble on account of their failure to shrink in the usual manner of steel castings, which it was thought was owing to the thinness of the metal and the unyielding nature of the cores.

Center Connection.—As stated in our issue of April 22, 1897, the two halves of the arch were erected simultaneously from the opposite shores, each half being held back during erection by a system of anchor-rods capable of being lengthened and shortened by a special toggle joint arrangement. Naturally the closure at the middle was anticipated with considerable interest, since upon its accuracy depended the work which would have to be done to secure the proper distribution of the load between the top chord and the arch rib.

In the proper order of events, when the toggles were slackened away, the top chords should have met first, and, then, as they passed from tension to compression, the ribs should have met. As a matter of fact, the exact reverse was the case; the ribs met first and when the anchorages were entirely slackened off there was an opening at the

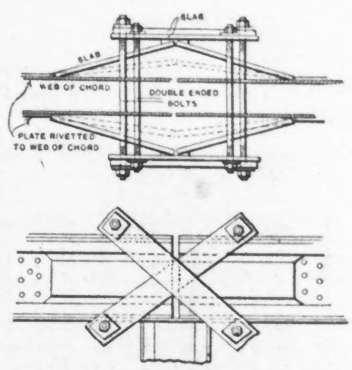


Fig. 2.—Compression Toggle Used to Force Apart Top Chord of Arch at Center.

center of the top chord of ½-in. This indicated no compression in the top chords at the center, whereas it was calculated that there should have been about 350 tons. The cause or causes of the failure to close were not at the time very obvious, but it was decided that the adjustment could be duly effected after casting off the anchorages. The anchorages were therefore cast off and taken apart. None of the joints were riveted up at the time, but almost all holes were filled with drift pins and bolts. Certain of the rib joints were open, the bearing faces being held apart by drift pins and bolts. When these were removed so as to allow the bearing pieces to come together the opening in the top chord at the center was reduced to ¼-in. It then became necessary in order to secure the required compression in the top chord to force it apart at the center and insert a shim. This was done by means of a compression toggle shown roughly by Fig. 2. This toggle was improvised from material on the ground and served the purpose intended satisfactorily. The chords were forced apart until the opening was 1 in. wide, and a shim conforming to the section of the chord and 1 in. thick was inserted. The amount of pressure exerted by the toggle, while it was not accurately determined, was just sufficient to induce the proper camber which it was calculated the bridge should have.

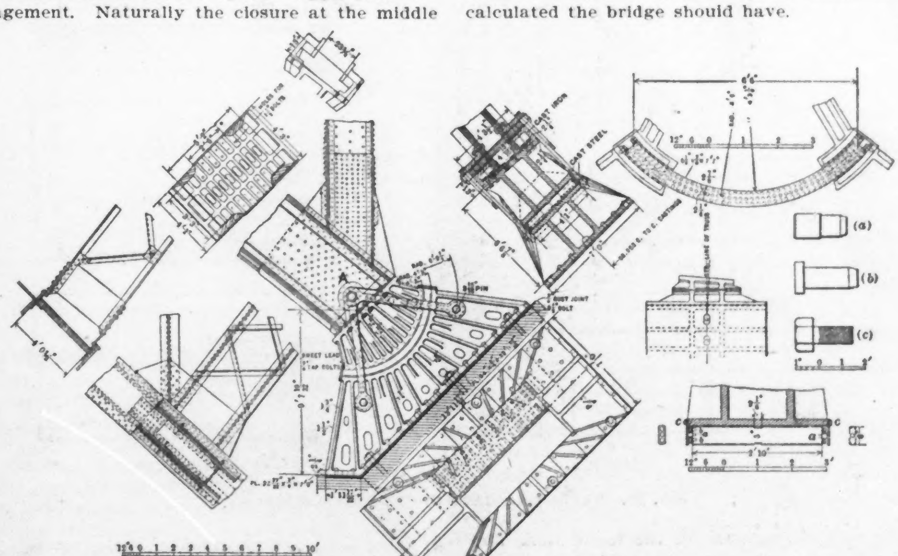


FIG 1.—DETAILS OF SKEWBACK AND END POST CONNECTION WITH RIB, GRAND TRUNK RY. ARCH, NIAGARA FALLS, N. Y.

Rigidity.—Both the tests and the actual operation of the bridge under traffic have shown it to be a remarkable rigid structure. Fig. 3 shows the test load placed on each track. When this load covered the entire length of the bridge on both tracks the deflection of the arch at the center was 13-16-in. Immediately upon the removal of the load the arch returned to its original position. In operation practically no lateral movement has been observed.

BEAR TRAP DAM FOR REGULATING WORKS, CHICAGO DRAINAGE CANAL.

(With two-page plate.)

II.

In the preceding article describing this work, published in Engineering News of March 24, 1898, the superstructure of the dam was illustrated in detail, and in this issue the description is completed, with illustrations of the foundations and that part of the superstructure having to do particularly with the operating mechanism.

Foundation Masonry.—The foundations of the bear trap dam consist of concrete masonry and imbedded and attached metalwork of the forms shown by Figs. 16 and 17, and in detail by other illustrations to be mentioned further on. Broadly speaking, the work may be divided into (1) the abutments at each end of the dam, and (2) the foundations between the abutments. Considering first the abutments, it will be seen that each consists of a weir-tube pit, counterweight pit, various gate pits, and the passages connecting them with each other and with the tail race and main channel, all constructed in concrete. This concrete is made according to the following specifications:

Broken Stone.—The broken stone shall be of hard and sound limestone, free from dust and dirt, the largest stones being of such size that they will pass through a ring 1 in. in diameter.

Cement.—The best Portland and natural cements shall be used, brand and quality to be subject to approval by the Chief Engineer, who shall, from time to time, cause such tests to be made as may seem to him proper for determining the quality of cement to be used in the work. The development of tensile strength shall be for Portland cement 400 lbs. per sq. in. and for natural cement 100 per sq. in. in seven days.

Portland Cement Mortar.—This shall be made in the proportion of 100 lbs. of cement to 2 cu. ft. of sand.

Natural Cement Mortar.—This shall be made in the proportion of 67 lbs. of cement to 1 cu. ft. of sand.

Natural Cement Concrete.—This shall consist of two parts by volume of broken stone to one part by volume of natural cement mortar.

The bulk of the masonry is to be of natural cement concrete, but all exterior surfaces are to have a 3-in. coating of Portland cement mortar and the surfaces of pits, well holes, passages, etc., are to have a 3-in. coating of natural cement mortar. The concrete is laid in horizontal layers 4 ins. thick, and great care is taken to secure perfect workmanship.

The foundation between the abutments consists of two prismoids or walls of concrete, one forming the rear of the dam chamber and an anchorage for the downstream hinge; the other forming the front of the dam chamber and the track for the upstream leaf travel, and containing the inlet conduit from the channel. These walls are constructed of concrete of the composition and quality of manufacture already described for the abutments. With the foregoing and the drawings, Figs. 16 and 17, the foundation masonry will be clear in so far as its purely structural features are concerned.

Foundation Metalwork.—Under this head are included:

(1) The cast-iron chairs to carry the hinges for the downstream leaf, twelve in number and of the dimensions shown by Fig. 18. These chairs are anchored to the concrete by steel bolts of the dimensions shown by Fig. 19. After setting each bolt is to withstand a test pull of 10,000 lbs. Besides the chairs there will be, of the metalwork under the dam, anchor rods for the holding down chains of the construction shown by Fig. 19, and shrouds for the downstream hinge of the construction shown by Fig. 20.

(2) The track for the upstream leaf rollers. This consists of a series of 21 triangular trusses constructed as shown by Fig. 21, and located as shown by Fig. 16, and carrying the track bars on which the rollers of the upstream leaf travel. In constructing, the track bars, one at each truss, is to be first adjusted by bolts and wedges, and after testing by the engineer the frames are to be imbedded in the concrete. The joints between the track bars and Z-bars are then to be filled with melted lead. The intermediate track bars may then be lined in by those already set. After all are set each track bolt is to be screwed up hard and the whole system tested for true plane. Next the sheeting plates are to be placed, the required curve being put into the plates by screw bolts passing through iron thimbles made to fit the places where used. After final approval the specified concrete and mortar backing is to be placed. The outside dimensions of the track frame are 158 ft. 11⅝ ins. x 18 ft. 9 ins.

(3) End shrouds at abutments. The construction and location of these shrouds are shown by Figs. 16 and 17.

(4) The main gates. The locations of these gates are shown by Figs. 16 and 17, each gate being numbered. All gates, Nos. 1 to 5, inclusive, are of similar construction, and are operated by hydraulic cylinders. Their main structural features are shown in the accompanying table:

Table Showing Characteristics of Gates and Their Operating Machinery.

Reference.	Cylinder length, ft.	Cylinder length, ins.	Piston rod, ft.	Piston rod, ins.	Frame length, ft.	Frame length, ins.	Connecting rod, ft.	Connecting rod, ins.	Gate length, ft.	Gate length, ins.	Gate width, ft.	Gate width, ins.	No. required.
No. 1....	7	8	8	11⅝	19	2	31	8	7	9	8	5	2
No. 2....	7	8	8	3⅝	18	6	16	5	9	0	8	5	3
No. 3....	7	8	8	11⅝	19	2	29	8	7	9	7	5	1
No. 4....	0	0	0	00	00	0	00	0	10	0	8	5	1
No. 5....	0	0	0	00	00	0	00	0	4	6	4	5	2

Full details of these gates and their operating cylinders are shown by Fig. 22. The gates operate in Z-bar frames built into the conduits and embedded in 3 ins. of Portland cement mortar. The timber used is to be white oak water-soaked into final size when fitted into place. The operating gear is to be truly lined in place and built into the concrete, with at least 3 ins. of Portland cement mortar about all parts in the concrete. Other details of construction are shown by the drawings.

(4) Pipes and specials. Details of these are shown by Figs. 16, 17 and 23, and need not be described further except to state that all are built into the concrete with beds of 3 ins. of Portland cement mortar. The same drawings, Figs. 16, 17 and 23, show details of the small valve construction.

(5) Trombone valve. This valve plays an important part in the operation of the dam, as will be shown further on, and its construction is shown in detail by Fig. 23. There are two of these valves located as shown by Figs. 16 and 17.

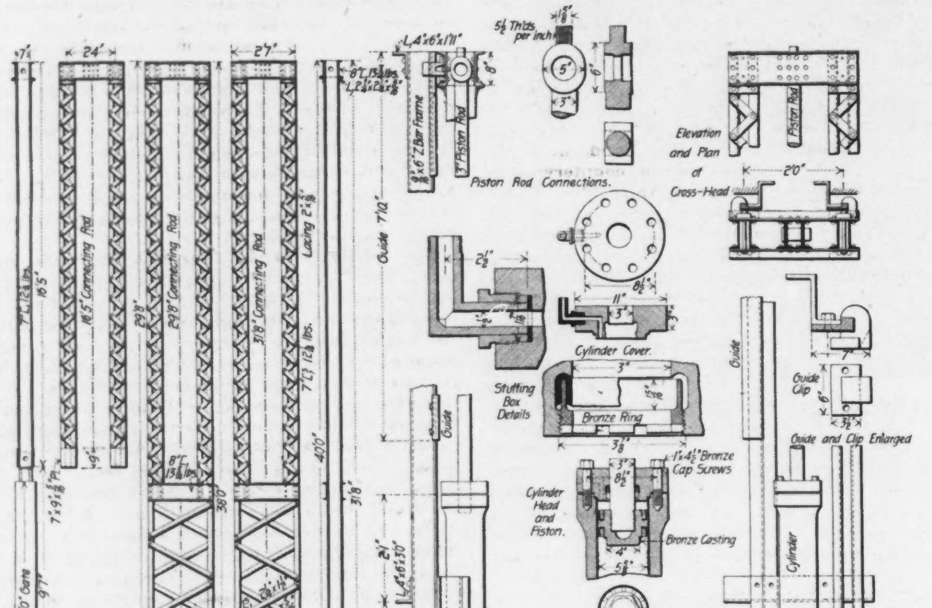


FIG. 22.—GATES AND GATE OPERATING MACHINERY.

(6) Weir tubes. These, like the trombone valve, are used in the operation of the dam. Their construction is shown by Fig. 24, and their location by Figs. 16 and 17.

The foregoing cover the principal parts of the foundation metalwork, and with the aid of the drawings are easily understood as far as these

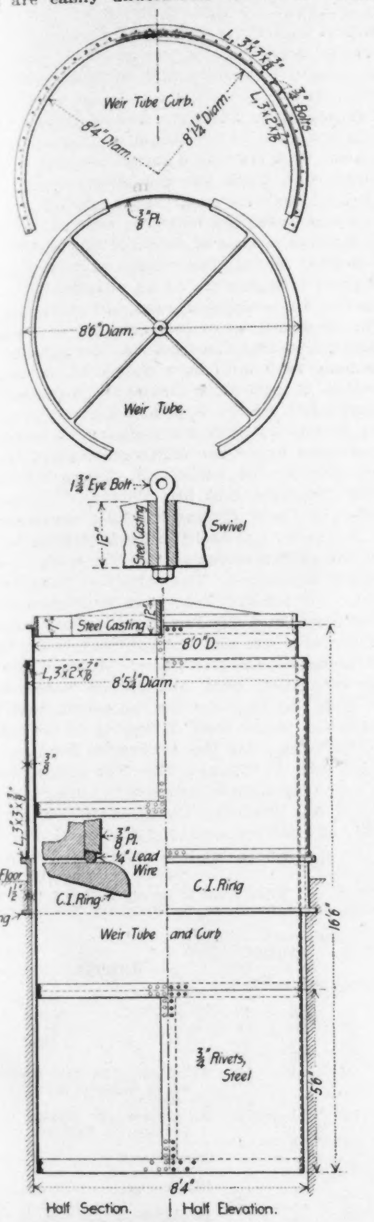


Fig. 24.—Weir Tube Details.

structural features are concerned. The part that some of the constructions play in the operation of the dam will be described later.

Foundation Timberwork.—The timberwork is not large in amount. It is all white oak watersoaked to true dimensions, and located as shown in Figs. 16, 17 and 22. Briefly stated, it consists of 12-in. floors in the bottom of the counterweight pits; 6-in. floors in the weir tube counterweight pits; the gate timbers, and timber to fill the slots in front of the operating gear for gates Nos. 1 and 3.

Operating Mechanism.—To render the theory and action of the operating mechanism for the bear trap dam clear, it is desirable to consider its various factors consecutively, and in as close order as possible. Accordingly, the foregoing description has been confined almost entirely to the purely structural features of the dam. The primary operating force of this, as of any other dam of the bear trap type, is of course the head of water between the main channel and the tail race. Owing, however, to the great size and weight of the dam, the application of this force required precautions in regulation and control not necessary in dams of small dimensions, such as have been built in the past. Non-parallel motion or warping was perhaps the thing to be feared most, but there were a variety of other problems, as has already been stated in the previous article.

To understand the theory of the operating machinery it will, perhaps, be best to consider the counterweighting first. As shown by Fig. 25, and further described in the previous article, the ends of the upstream leaf of the dam extend beyond the 160-ft. opening past the upstream side of the abutments, and are especially designed to connect with wire ropes passing over sheaves and fastening to cylindrical counterweights moving vertically in suitable pits in the masonry. The conditions of the forces acting on the dam, as already indicated, will be such that at its higher positions it is not desirable that there shall be a counterweight. At these positions of the dam the counterweights will be at their lower positions, and if then immersed in water they may be partly or wholly afloat. On the other hand, when the dam is at its lower positions the counterweights will be needed and will be at their higher positions. In coming to the higher positions they may be gradually withdrawn from immersion and thus be suspended from the dam in a degree depending on the extent of immersion. The diameter of the counterweights has been so determined and the elevation of water in the pits so disposed that, when the dam is at its highest position the counterweights will just be afloat, and when at its lowest position the weight of the dam will just be counterbalanced. Even in this position the counterweight, as designed, will still be immersed to a depth of 8 ft., so that it has an excess of weight much in excess of that needed to accomplish the results just stated. The purpose of this is as follows: Suppose the dam be raised to its highest position with water under it. The counterweight will then rest on the bottom of the pit. This being the case, the water in the pit may be pumped out without causing any of the weight to be applied to the dam. Then the water under the dam may be allowed to flow out, or may be pumped out, but it cannot lower because it will at once be suspended from the counterweights, which, since the pit is empty, will have a weight much in excess of the active weight of the dam

the jack A at one end is connected by means of pipes to the cylinder of the jack at the other end, which works in the opposite direction, that is jack B. The system thus arranged is filled with a liquid, which being done, the constancy of volume of the liquid renders necessary a parallel travel of the crest of the dam as it raises or lowers. Details of the hydraulic jacks are shown by Fig. 26. They are designed to work against a load of 40 tons each.

The dam might be operated by means of these jacks and the counterweights alone if it were not for the load of water on it when in action. This load is so heavy, however, that it must be counteracted by the upper pressures under the dam, so that these pressures become the active operating agents, and the power that may be derived from the jacks and counterweights simply becomes an adjunct. They add greatly to the conservatism of the design, and constitute a balance of power which is sufficient at all times to hold the structure under safe control, a desirable end that could not be accomplished except through the agency of the plate girder nature of the upstream leaf of the dam.

The constructions for operating the dam are quite fully illustrated in the plans for foundations and abutments, Figs. 16 and 17. A conduit traverses the length of the dam, and is connected with the space under the dam by a number of branch openings. These openings are disposed principally with the view of diminishing velocities to a minimum and so reducing tendencies to unequal pressures, which would tend to cause unequal raising or lowering of the dam. The nature of the ground upon which the structure sets, being a rather unsound rock, has also governed somewhat the disposition of the constructions. The conduit terminates at either end at the base of a pit in which a vertical cylindrical valve is placed. Water is admitted in constant and continuous quantity to the conduit through gates, as shown, at the up-

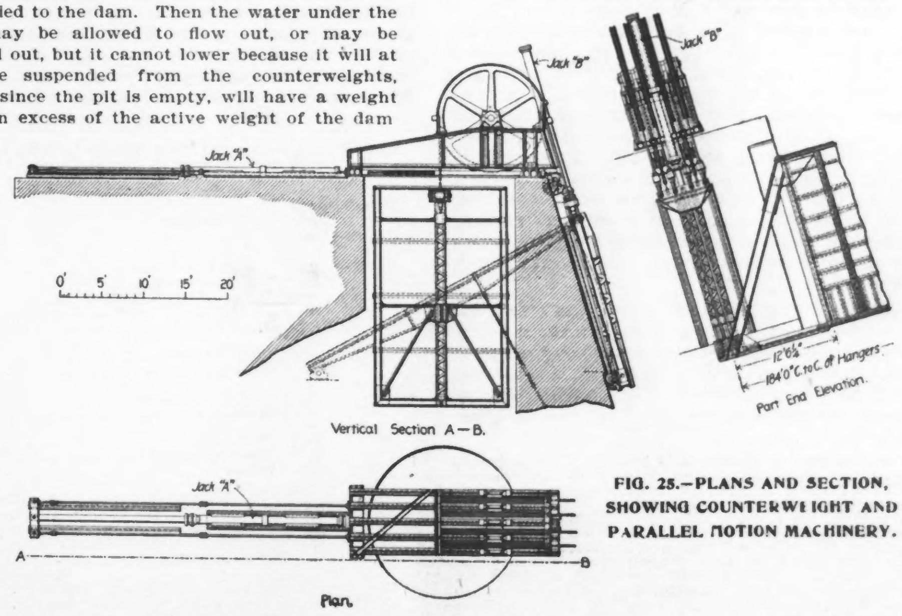


FIG. 25.—PLANS AND SECTION, SHOWING COUNTERWEIGHT AND PARALLEL MOTION MACHINERY.

Thus suspended, the space under the dam may be entered for purposes of examination and repairs. The design is such, for instance, that any one or more of the rollers may be removed or replaced.

The level of water in the counterweight pit may be regulated within certain limits by what is termed the "trombone" valve. A constant but small flow is permitted through the pit. The dimensions of the openings are so adjusted that, with any possible speed of movement of the weight the level of water cannot vary beyond desirable limits. The amount of counterweight on the dam may thus be readily regulated should occasion require.

The parallel motion device consists of four hydraulic jacks disposed as shown by Fig. 25, i. e., two at each end of the dam. The jacks at each end work in opposite directions, as is clear from Fig. 25, where the two jacks are for convenience designated as A and B; A exerting a pull, and B a push on the upstream leaf. Now the cylinder of

stream face of abutments. This water, together with leakage around the boundaries of the dam, finds egress over the top of the cylindrical valve, which is designated the "weir tube." This tube is 8 ft. in diameter, thus forming a weir about 25 ft. long at its upper periphery. The quantity of water which will flow over the top of this tube with a small head of water above its top is so large that any variations of leakage or water otherwise admitted to the conduit will not cause any material change.

To raise the dam the "weir tube" is raised until the elevation of water surface under the dam is proper for the purpose. Similarly, to lower the dam the "weir tube" is lowered. The weir tube can be raised until its top is above the highest water surface in the channel, at which level the full head of water in the channel can be made effective under the dam. It can be lowered to a level below the lowest level in the tail race or channel.

A device is attached to the "weir tube" by which the maximum depth of water on the crest of the dam may be regulated. A chain connects the top of the "weir tube" with the end of the horizontal hydraulic jack, as shown on the plans. The length of this chain is adjustable. It can be set so that any desired amount of slack will be left in it when no water is on the crest of the dam. As the dam lowers the jack plunger gradually takes this slack out of the chain, and when it is finally taken out the "weir tube" is made to rise automatically, and thus cause the dam to rise. This chain is so arranged with pulleys that when its slack is all taken up the weir tube is caused to rise twice as fast as the crest of the dam lowers.

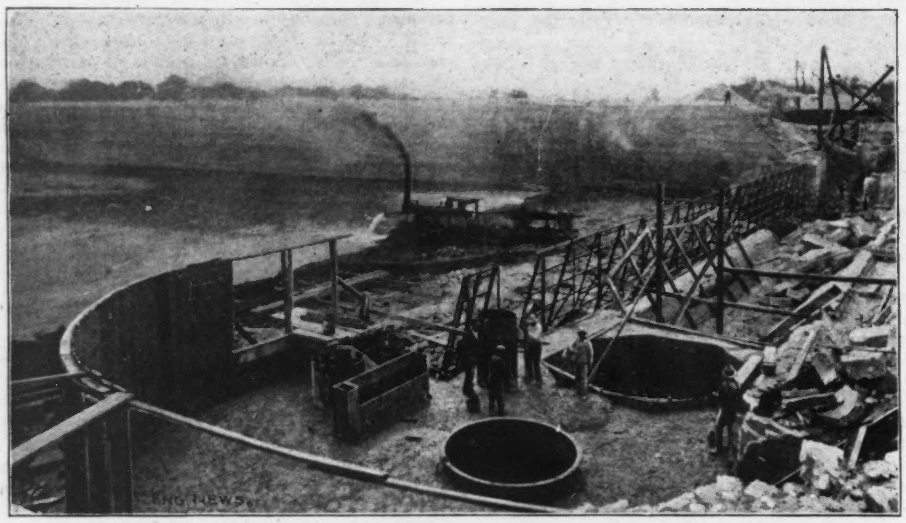


FIG. 27.—VIEW OF BEAR TRAP DAM FOUNDATIONS UNDER CONSTRUCTION.

The description of the operating mechanism has been made very brief, but if studied in connection with the illustrations it will, we think, be clearly understood. It is obvious, of course, that there must be considerable supplementary equipment in the nature of pressure pumps, gearing, levers, etc., for furnishing and applying the power and properly manipulating the different mechanism, but as this will be of ordinary, simple construction, its description need not be entered into here, especially as the drawing and descriptions which are given indicate its extent and nature quite clearly.

Material.—It is desirable, however, to give briefly the nature of the material used in the machine construction. The qualities required of all plate and shape metal, cast-iron and steel, and all masonry have been described. The following are the special requirements demanded for the machiney material:

Cast-iron used in gearing is to have an ultimate tensile strength of [illegible],000 lbs. per sq. in. All bronze, whether Tobin, aluminum or phosphor bronze, is to meet the following requirements:

Ultimate tensile strength............60,000 lbs. per sq. in.
Maximum elastic limit ....25,000 " " "
Maximum elongation in 8 ins. 15%

All chain is to be made of best chain iron and for $\frac{5}{8}$-in. chain is to have a breaking strength of 23,800 lbs. and withstand without distortion a proof load of 11,900 lbs. For $\frac{3}{8}$-in. chain the corresponding loads are 7,200 lbs. and 3,600 lbs.

For machinery all material and workmanship shall be first-class in every particular, and all parts shall be made as rigid and durable as practicable by approved shop methods. The journals and bearings shall be made with the least practicable amount of spring and lost motion. Such details as may not be fully developed or shown on the drawings, shall be developed in harmony with the design. So far as practicable, all similar parts shall be made duplicate and interchangeable. All subject to the approval of the Chief Engineer. In general, all journals and shaft bearings and all other friction surfaces shall be lined with brass or other approved non-corrosive metal, and every precaution used to insure durability and easy working after standing idle exposed to weather conditions for long periods of time. All materials are designed to expand over a range of 150° F., and proper provisions for such expansion shall be made both in construction and erection.

Shop Work.—The shop work both for the sluice gates and the bear trap was done by the Lassig Bridge Works, of Chicago, Ill., of which Mr. August Ziesing was then Chief Engineer. Generally it calls for no particular mention, the machine work being largely of very ordinary character, as is evident from a study of the drawings. The most particular care necessary was in turning the plungers for the hydraulic jacks, the milling of the Tobin bronze wedge bearings for the sluice gates, and the shaft and journal work for the bearing rollers and sheaves. No especially designed machinery was needed for any of this work.

Inspection.—All metal work is inspected before leaving the shop, the work being in charge of Mr. T. L. Condron, Resident Engineer, Pittsburg Testing Laboratory, and his assistants. The variety of the constructions, which includes machine work of various kinds, as well as cast-iron and steel and wrought metal, riveted, shape work, made the duty of inspection one in which a careful and systematic method was more than usually necessary. The first work of the inspecting contractors was to divide the work into distinctive classes corresponding partly to the character of the work and partly to the natural divisions of the structure itself. For example, the bear trap dam work was divided into the following classes: (1) Upstream leaf; (2) Downstream leaf; (3) Operating machinery—riveted; (4) Castings; (5) Machine and blacksmith shop work. These classes were then sub-divided into "members," and each "member" given a separate number, which was made known to the engineers of the Sanitary District and other interested persons. A special form of report blank was prepared according to the schedule outlined, and on this weekly reports were made by the inspectors to the Chief Engineer of the Sanitary District. One of these weekly reports is shown in the accompanying table. It will be seen that from this report the Chief Engineer knows each week the condition of each item of the work and its progress as a whole, as far as the shop work and shipping are concerned. His engineer in charge of construction on the ground, of course, records the receipt of material and its progress in erection. As an example of the latest practice in inspection work the system outlined will, we think, be of interest.

Engineers and Contractors.—As already stated, the bear trap dam here described is being built for the Chicago Main Drainage Canal, now being constructed by the Sanitary District of Chicago, and it follows that its design and construction have come under the engineer corps of the Sanitary District, of which Mr. Isham Randolph is Chief Engineer, and Mr. Thomas T. Johnston is Assistant Chief Engineer. As a matter of fact, Mr. Johnston has had the work directly in charge and the design is essentially the work of himself and his assistants. The contracts being let separately, (1) for the bear trap superstructure and machinery, and (2) for the foundation masonry and metal-work, and the contractors for the former being required to present designs and drawings with their bids, Mr. Alfred Noble, M. Am. Soc. C. E., as engineer for the contractors, had in charge the metal-work designing of the bear trap superstructure for the successful bidders, Christie & Lowe, of Chicago, Ill. The sluice gates and the bear trap foundations are the design in all details of the Drainage Canal engineers, Mr. E. L. Cooley of that force having had particular charge of the machinery and metal-work details. The

Ninth Weekly Report for Week Ending Nov. 14, 1896, of Bear Trap Dam Being Built at Lassig Bridge & Iron Works for the Sanitary District of Chicago, made to Isham Randolph, Chief Engineer, by Pittsburg Testing Laboratory, Ltd.

Members No.	Drawing No.	Members.	Number required.	Number Finished. This week.	Number Finished. Tot'l.	Number Shipped. This week.	Number Shipped. Tot'l.	Remarks.
		Upstream Leaf.						
1	2	Top flange plates	25	..	25	25	25	
2	2	Top flange angles	23	..	23	23	23	
3	2	Bottom flange angles	24	..	24	24	24	
4	2	Bottom flange plates	27	..	27	27	27	
5	2—4	Diaphragms	40	21	38	11	11	All diaphragms have been riveted to adjacent girder.
6	2—5	Diagonal posts	2	..	..	..	..	Riveted up.
7	4—5	Girders	41	20	37	11	11	All girders are riveted to diaphragm, 37 finished.
8	4	Long bracing angles	4	4	4	4	4	
9	5	Shroud	2	..	..	..	..	Countersunk rivets to be chipped off smooth.
10	6	Main hanger	2	..	..	..	..	Riveted up.
11	9	Masonry guard	2	..	2	..	2	
12	9	Tracks	84	38	38	..	..	14 planed on one side, 11 planed on both sides, 38 finished
		Downstream Leaf.						
13	1—3	Girders	41	..	41	8	41	
14	1—3	Diaphragms	40	..	40	6	40	
15	3	Transverse bracing sets	3	3	3	3	3	
16	3	Sway bracing sets	76	..	76	..	76	
		Operating Machinery, Riveted.						
17	6	Supports for hydraulic cylinder	2	2	2	..	..	
18	6	Cross heads, horizontal jacks	2	..	..	..	..	Riveted up.
19	6	Girders for jacks	8	..	..	..	..	Riveted up.
20	7	Sheave girders	10	..	10	..	10	
21	7	Standards for rope guards	8	8	8	..	..	
22	8	Counterweight buckets coup.	2	..	2	..	2	
		Castings.						
23	1—9	Cast-steel chairs	41	16	16	..	..	Being planed and bored, 16 finished.
24	6	Chain pipe	4	..	..	..	..	
25	7	Castings for sheave anchors	10	..	..	..	..	
26	8—13	Cast-steel rope sockets	12	..	..	..	..	
27	10	Sheaves	8	..	..	..	..	
28	10	Sheave pedestals	10	..	..	..	..	Being fitted, planed, etc.
29	11	Cast bed plates	4	4	4	..	..	Ready for shipment.
30	11	Chain sheaves	4	..	..	..	..	Turned up.
31	11	Supports for rods	4	..	..	..	..	Cast but not yet planed.
32	11	Chain sheave pedestals	4	..	..	..	..	
33	12	Plunger sylinders	8	..	..	..	..	
		Machine and Blacksmith-Shop Work.						
34	1	5-in. hinge pins	82	41	41	..	..	One set finished, others turned.
35	4	Wheel bearings	128	128	128	33	33	All finished.
36	4—5	Sets of bearing wheels and shafts	44	44	36	11	11	
37	8	Pins for rope sockets	4	..	4	..	4	
38	10	10-in. shafts for sheaves	2	2	2	..	..	Finished except field work.
39	12	Plungers	4	..	..	..	..	
40	13	Wire ropes	8	..	..	..	..	
41	3	Anchor chains coup.	41	..	41	..	41	
42	3	Anchor bolts for chairs	164	..	..	..	..	
43	6	Rods for jacks	4	..	..	..	..	Forged but not finished.
44	6	Clevis rods for ropes	8	..	..	..	..	
45	6	1½-in. crane chain	4	..	4	..	4	
46	7	Anchor rods for sheave girders	76	..	..	..	..	

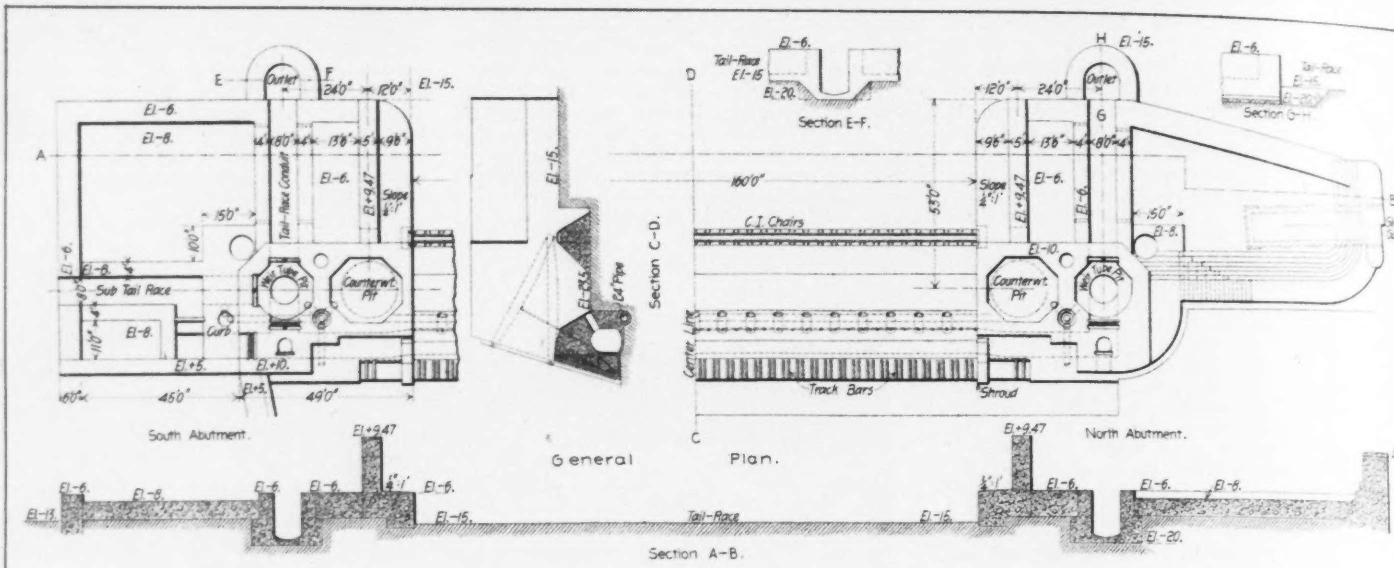


FIG. 16. GENERAL PLAN AND SECTIONS OF BEAR TRAP FOUNDATIONS.

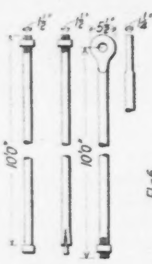


FIG. 19.
ANCHOR BOLTS
FOR
HINGES AND CHAINS.

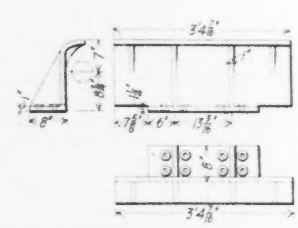
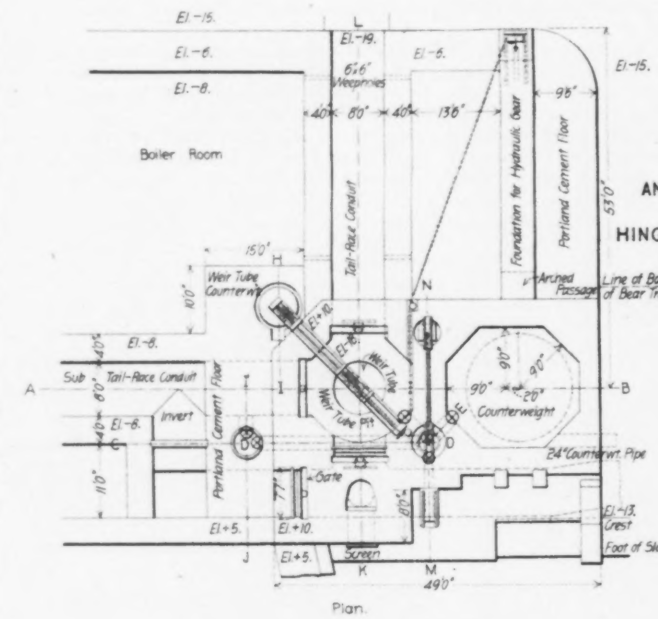
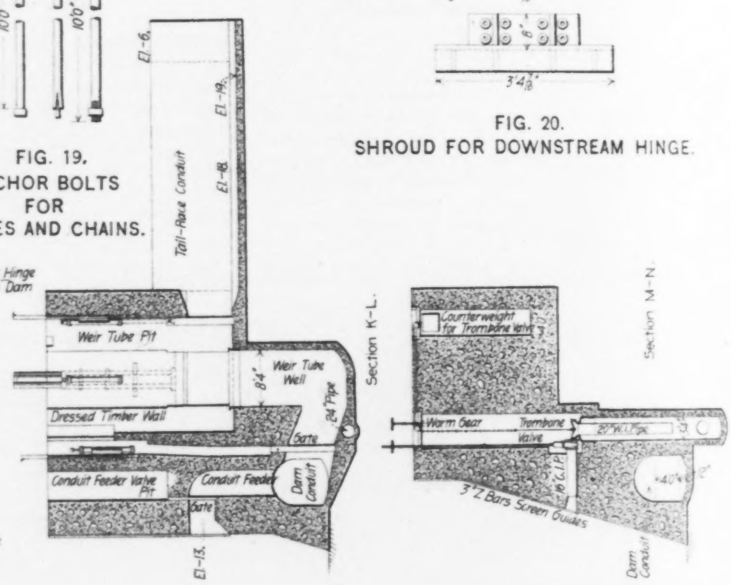


FIG. 20.
SHROUD FOR DOWNSTREAM HINGE.





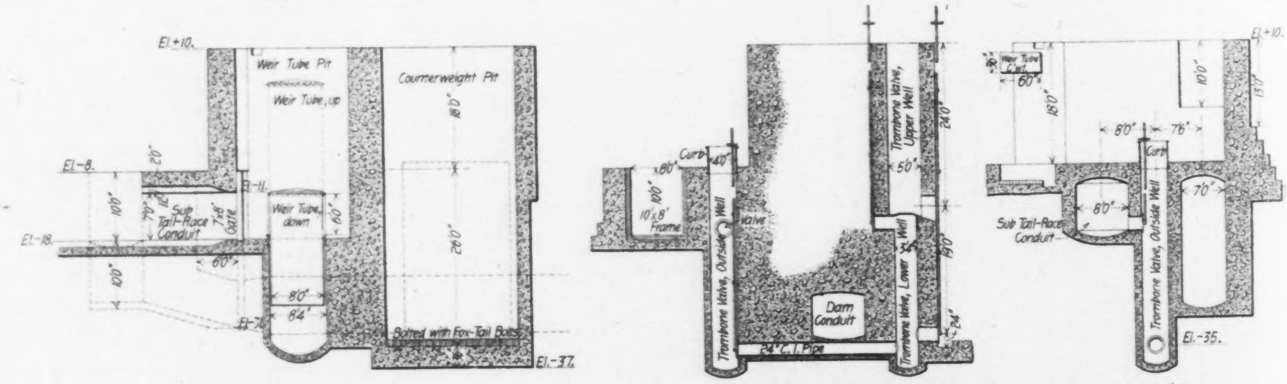


FIG. 17. PLAN AND DETAILED SECTIONS SHOWING WELL AND CONDUIT CONSTRUCTION.

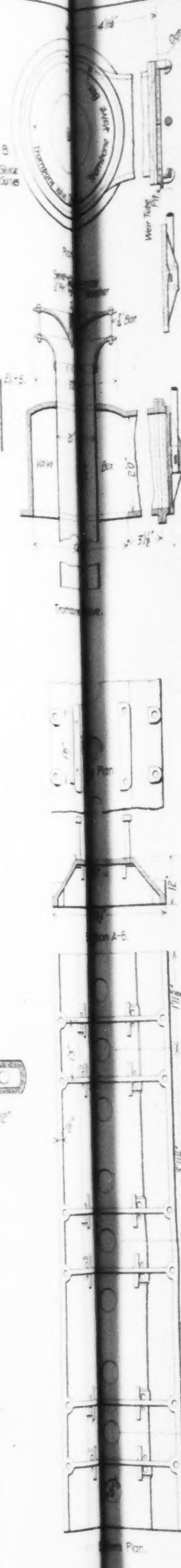
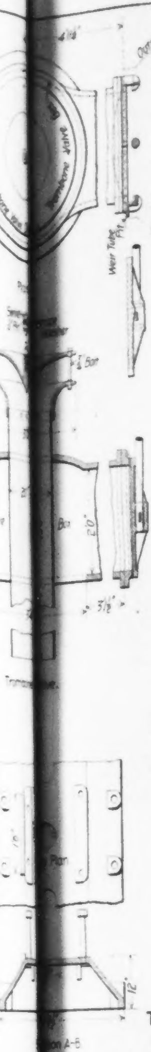


FIG. 18. CH
DOWNSTREA

BEAR TRAP DAM, CHICAGO MAIN DRAINAGE CHANNEL (SUB

Isham Randolph, Chief Engineer. } Sanitary District
Thos. T. Johnston, Assistant Chief Engineer. } of Chicago.



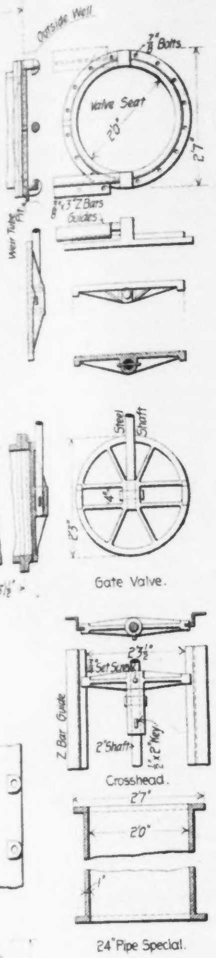


FIG. 23.
TROMBONE VALVE AND
GATE VALVE DETAILS.

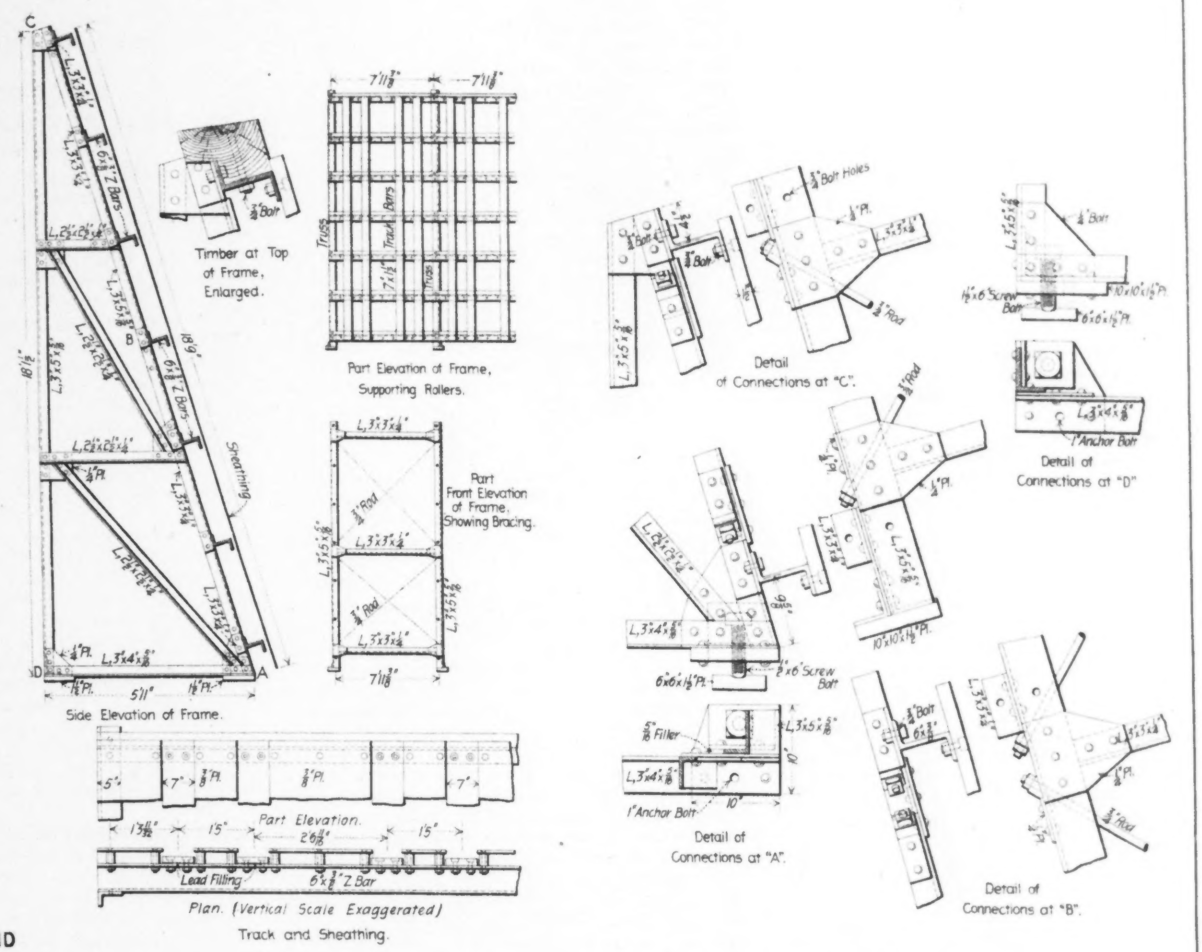


FIG. 21. TRACK CONSTRUCTION FOR UPSTREAM LEAF ROLLERS.

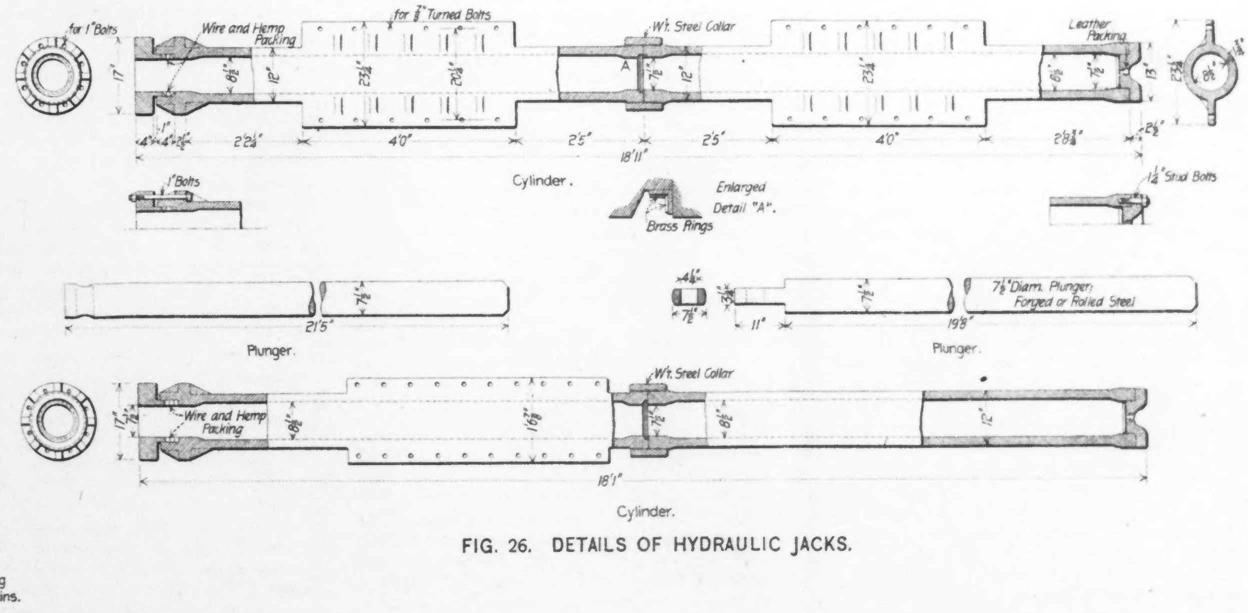


FIG. 26. DETAILS OF HYDRAULIC JACKS.

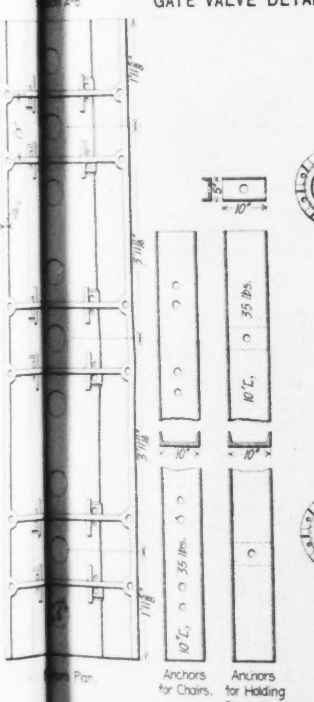


FIG. 18. CHAIRS FOR
DOWNSTREAM HINGES.

HANNEL (SUBSTRUCTURE AND OPERATING MACHINERY.)

E. L. Cooley, Designer of Structural Details.

C. L. Harrison, Engineer in Charge of Construction.

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

contractors for the sluice gates are Christie & Lowe. Mr. C. L. Harrison was the Engineer in Charge of Construction for the Sanitary District. All the metal-work, as before stated, is being inspected by the Pittsburg Testing Laboratory, and the structural metal-work for Christie & Lowe is being done by the Lassig Bridge Works, of Chicago.

THE PROPOSED NEW CHARTER FOR THE CITY OF SAN FRANCISCO.

On May 26, the date of the present issue of this journal, the people of San Francisco are to vote on the adoption of a new city charter. The proceedings are being taken under a provision of the State constitution that any city with more than 3,500 inhabitants may adopt a new city charter, subject to the approval of the State legislature. The draft of the charter in such cases is to be made by 15 freeholders, elected by the people for that purpose, who submit the results of their work to the voters for final approval. The proposed San Francisco charter will go to the legislature for approval in 1899, and if approved will take effect on Jan. 1, 1900. This will be the fifth charter drawn for San Francisco in the last 20 years, those proposed in 1880, 1883, 1887 and 1893 having failed of confirmation.

The initiative in the present attempt was taken in December, 1896, by the Merchants' Association, which petitioned the mayor to appoint a citizens' committee of 100 to formulate the main provisions of a charter. In our issue of Oct. 14, 1897, some of the proposed features of the charter, relating to the department of public works and the city engineer, were outlined in a letter from a correspondent in San Francisco. A second letter on the same subject appeared in our issue of Nov. 11, 1897. The 15 freeholders were elected on Dec. 27, 1897, and submitted the draft of the charter on March 26, 1898, within the 90 days required by law.

The minuteness of detail of the proposed charter is partially indicated by the fact that the document occupies more than seven closely printed pages of the San Francisco "Call." Some of the most notable features of the charter are the extent to which it separates legislative and administrative duties; its "direct legislation" and "referendum" clauses, under which ordinances may be enacted and certain classes of ordinances vetoed by a popular vote; the importance of the office of mayor; the rather large range of duties imposed upon the department of public works; the restrictions relating to franchise legislation; and the provisions for the acquisition by the city of all public utilities, such as water-works, lighting and street railway plants.

The legislative powers are vested in a board of 18 supervisors, elected from the city and county at large (city and county being coterminous). The supervisors serve for two years at a nominal salary of $1,200 each. Their power of appointment is confined to the clerks of their own body and a sergeant-at-arms. The supervisors have control of the financial budget of the city, but all salaries are either fixed by law or determined by the heads of the several departments.

Provision is made for direct legislation by the voters and for amendments to the charter as follows: The proposed ordinance or amendments are to be submitted to the election commissioners, accompanied by a petition signed by voters equal in number to at least 15% of the votes cast at the last preceding State or city election. The commissioners thereupon order an election. If a majority of the votes cast at such an election are in favor of the ordinance or amendment to the charter the same goes into effect within a stipulated time. Ordinances so enacted cannot be repealed by the supervisors, but that body may propose amendments to such ordinances, which are then submitted to popular vote at the next regular election.

Regarding the referendum the charter says:

> Except as otherwise provided in the Constitution of the State, or as otherwise provided in this charter, every ordinance involving the granting by the city and county of any franchise for the supply of light or water, or for the lease or sale of any public utility, or for the purchase of land of more than $50,000 in value must be submitted to the vote of the electors of the city and county at the election next ensuing after the adoption of said ordinance.

On petition certain other franchise ordinances must be referred to the people, as explained later.

The mayor is to be elected for two years and to have a salary of $6,000 a year. He presides over the meetings of the supervisors and may veto any of their resolutions or ordinances, but such veto may be overridden by the vote of 14 of the 18 supervisors. In the case of appropriations the mayor may veto one or more single items and approve the balance. All heads of departments not elected by the people are appointed by the mayor. Any appointed officer may be removed by the mayor for cause, and any elected officer, except a supervisor, may be suspended by the mayor and removed by the supervisors for cause. The boards or commissions appointed by the mayor are as follows, each having from three to five members, except the board of health, which has seven, two being ex-officio: Public works, park, police, fire, health, education, election and civil service, besides which there is a department of electricity composed of the members of the fire and police boards. The duties and powers of these bodies are set forth in the charter.

The board of public works, in which most interest centers for our readers, is composed of three members "who shall give all their time during official business hours to the duties of their office," and shall receive a salary of $4,000 a year each. No two commissioners shall be members of the same political party, and no one shall be eligible for the office who is not at the time and has not been for the preceding five years an elector of the city. When the charter was being drawn an unsuccessful attempt was made to secure the insertion of a provision that one of the commissioners should be a civil engineer of at least ten years' standing. The board is to appoint a city engineer, who must be a civil engineer of at least "five years' practical experience." The city engineer "shall serve the board exclusively and shall not be engaged in any other business while he is in its service." All the assistants to the city engineer, like all the other employees of the board except its secretary, are to be appointed by the board. The charter provides that the secretary shall have a salary of $1,800 a year. The compensation of the city engineer and all other employees is to be fixed by the board, "but no compensation to any of said persons shall be greater than is paid in the case of similar employments," whatever this may mean. The city engineer "shall hold his office at the pleasure of the board." He is to do all the engineering work of the board, and "no street assessment shall be valid without his certificate as to the quantities" and that the work conforms to the "official lines, elevations and grades."

Subject to the ordinances of the supervisors, the board of public works will "have charge, superintendence and control" of all public streets and ways; sewers, drains and cesspools; street sprinkling, cleaning and lighting and the lighting of parks; all buildings; the construction of buildings and structures for other city departments; the collection and disposal of garbage and refuse; wires and conduits; and of all public utilities owned and operated by the city at any time. No street work or improvement of any kind shall be ordered by the supervisors unless recommended by the board of public works.

The health board is to be composed of five appointed members, who must be physicians, the president of the board of public works and the chief of police. This board must act for the most part under ordinances enacted by the supervisors, and is directed to submit drafts of ordinances to the supervisors as new ones become necessary. One of the park commissioners must be an artist, and no work of art may be placed in the parks without the approval of the park commissioners, both as to character and location. Other departments may call on the park commissioners for the approval of the designs for buildings, bridges, gates, lamps, and for the approval of "lines, grades and plotting of public ways." Members of the health board and park commission will receive no compensation for their services.

Most of the employees of the city are to be selected from lists prepared by a civil service commission; laborers are to be given work in order of application, and all others must be subjected to examination. All laborers on contract work shall receive at least $2 per day and be required to work not more than eight hours per day.

Some of the chief provisions of the charter relating to franchises are as follows: No exclusive franchise shall be granted for laying pipes, wires or conduits. Street railway franchises shall be limited to 25 years and shall be awarded to the highest bidder on the basis of gross receipts, but there must be paid to the city at least 3% of the gross receipts of the first five years, 4% for the next ten, and 5% for the last ten years. The supervisors are to have the right to regulate the rates of fare charged by any street railway company under franchises granted by them, and to "examine and expert their books as to such gross receipts." At the expiration of 25 years the track and all other fixtures on the streets are to become the property of the city, when it may either operate or lease the road as it sees fit.

The provisions just outlined also apply to franchises for erecting poles or wires for electric lighting or power.

All franchises for street railway, electric light or power plants shall require a three-fourths vote of all the supervisors for passage, and a five-sixths vote for passing it over the mayor's veto. At least 90 days must intervene between the introduction and final passage of such a franchise ordinance. Within 30 days of the approval of such an ordinance or passing it over the veto of the mayor a petition with signatures equal to 15% in number of the votes cast at the last preceding election may be filed with the supervisors asking that the franchise be submitted to popular vote. In such an event the franchise must be submitted "at the next election," when, unless it receives a majority of the votes cast, it shall not go into effect. A provision of the charter for submitting to popular vote ordinances granting franchises for light or water plants, or for the lease or sale of public utilities, has already been cited.

One division of the charter is devoted to the "Acquisition of Public Utilities," and is prefaced by the following statement:

> It is hereby declared to be the purpose and intention of the people of the city and county that its public utilities shall be gradually acquired and ultimately owned by the city and county.

The charter then proceeds to state that within one year after it goes into effect, and at least every two years thereafter, the supervisors must procure, through the city engineer, estimates of the cost of construction by the city of

> water-works, gas works, electric light works, steam, water or electric power works, telephone lines, street railroads and such other public utilities as the supervisors or the people by petition to the board may designate.

After securing these estimates the supervisors must call a special election for the purpose of submitting to the voters the question of acquiring, by construction, condemnation or purchase, "such or any of said public utilities as they may regard most important to the city and county to be first acquired." Before calling such an election "the supervisors must solicit and consider offers for the sale of existing utilities in order that the electors shall have the benefit of acquiring the same at the lowest possible cost." A vote on the acquisition of any public utility must be had whenever a petition so asking, with signatures equal to 15% in number of the votes cast at the last election, shall be submitted to the supervisors. In such a case the mayor may prepare and submit to the voters an alternative plan to that prepared by the supervisors. The proposition receiving the highest number of votes is to be adopted, provided that the sum of the votes cast in favor of each plan exceeds half of the total votes on the proposition.

As a precaution against evasion of this article it is provided that the neglect or refusal of any supervisor to comply with its provisions shall constitute cause for his removal. Who is to effect the removal in such a case the charter does not appear to state, except that it contains a general provision that any office shall become vacant when the incumbent, among other things, is "convicted of felony or of an offense involving a violation of his official duties."

Editorial comments on the charter are made elsewhere in this issue.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY.

D. McN. STAUFFER, Vice-President, CHARLES WHITING BAKER, Secretary, . . . EDITORS.
GEO. H. FROST, President, F. P. BURT, Treasurer, . . . BUSINESS MANAGERS.
WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, A. B. GILBERT, ASSOCIATE EDITORS.
CHAS. W. REINHARDT, . . . CHIEF DRAFTSMAN
ALFRED E. KORNFELD, New York, F. A. PECKHAM, Chicago, ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, ST. PAUL BUILDING, NEW YORK.
WESTERN OFFICE, MONADNOCK BLOCK, CHICAGO.

SUBSCRIPTION RATES: United States, Canada and Mexico, One Year, $5.00; 6 months, $2.50; 2 months, $1.00. To all other countries in the Postal Union: Regular Edition, One Year, $7.60 (31 shillings); Thin Paper Edition, One Year, $6.31 (26 shillings). SINGLE COPIES of any number in current year, 15 cents.

Mailing addresses may be changed at will by sending both old and new address. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 328 means that subscription is paid to the 32d week (that is the issue of Aug. 11) of the year 1898; the change of these figures is the only receipt sent, unless by special request.

ADVERTISING RATES: 20 cents per line. Want notices, special rates, see page 28. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

Our comment in our issue of May 5 concerning the need of armored cruisers of high speed in the United States Navy appears to be well illustrated by the course of current events. The reason why we possess only two vessels of this class, and these two protected by armor too light to enable them to cope with the best armored cruisers of foreign build, has been made very plain this week by statements from two authorities, one a former Secretary of the Navy, Gen. Benjamin F. Tracy, and the other that past master of naval strategy, Capt. A. H. Mahan, U. S. N. Gen. Tracy has said, in a widely published newspaper interview, that the reason for our lack of fast and heavily armored cruisers is that our new navy was planned on the idea that "it was to be a defensive navy, and not an offensive one." He freely admits that this is now seen to be an idiotic policy. The nation which occupies itself solely with defensive operations fights at an enormous disadvantage. The best mode of defense against an enemy is to attack him and compel him to use his fleets and armies in defending himself instead of in attack. This seems so clear now that every one can see it. It has been equally clear all the time to our army and naval officers who are students of the art of warfare, but it has not been understood at all by the Congressmen who have controlled naval appropriations and who have had the responsibility of deciding what classes of vessels should be built for the navy.

The statements by Captain Mahan above referred to are found in an admirable paper from his pen in the current number of "Harper's Magazine" on "Common Fallacies Respecting Naval Matters." One of these fallacies which he discusses in this paper is that the United States Navy should be planned primarily for defensive operations. It is entirely proper, says Captain Mahan, that our political attitude should be defensive rather than aggressive. It is a very creditable thing that the nation should take the position that it desires only peace with all nations, and that it will only make war if it is forced to do so. But however right it may be for the political rulers of the nation to take such an attitude, it does not at all follow that the nation's armament should be planned on the idea that we will act solely on the defensive. Our policy in international relations is one thing; our national defenses are quite another, and the latter should be planned for the purpose of striking hard blows at an enemy and compelling him to sue for peace regardless of our non-aggressive and pacific attitude as a nation. In brief, although Captain Mahan does not say so in so many words, it appears to be the case that our present lack of armored cruisers is due to the fact that Congressmen thought they knew better how to plan our national defenses than our experts who had made the art of waging war a lifelong study. It is worth noting that Captain Mahan's paper was written months ago, long before events had shown to people generally the folly of planning a navy with the idea that it should act purely on the defensive. But his comments could hardly have come at a more appropriate time.

As recorded in another column, a bill has been introduced in Congress which provides for the building of five heavily armored cruisers with speeds of at least 20 knots. Whether it will pass is rather doubtful in view of the great increase already provided for in the Naval Appropriation bill; but the need of more vessels of this sort must now be universally conceded. We could much better afford to do without the three additional battleships which have been provided for than these vessels.

The extreme rigidity of the new 550-ft. railway arch bridge at Niagara Falls, N. Y., which is described briefly in this and two preceding issues of Engineering News, will, we think, be recognized by engineers as one of the most remarkable features of this, in many respects, very notable structure. Sidewise there seems to be no sway to the bridge under the most trying loads as far as can be observed, while the vertical deflection of 13-16-in. under a load of over 7,000 lbs. per lineal foot is about as close an approach to immobility as the engineer can expect from structural materials. The question which is naturally asked is, to what is this almost perfect rigidity of the Niagara arch due? In the opinion of experts several things have contributed to the result. First of these, perhaps, is the inclination of the arch ribs toward the axis of the bridge. This factor was especially pointed out by Mr. Gustave Lindenthal, M. Am. Soc. C. E., in the course of a discussion of the Niagara arch at the last meeting of the American Society of Civil Engineers. According to Mr. Lindenthal a careful study of the most prominent metal arch bridges built in this country and abroad brings out prominently the fact that the movement under load is always more noticeable in bridges having parallel arch ribs, of whatever type they may be, than it is in bridges having the arch ribs inclined toward each other at the crown. As examples most familiar to American engineers, Mr. Lindenthal cited the Washington Bridge at New York and the Eads Bridge at St. Louis, both of which have parallel arch ribs and exhibit a noticeable vibration both laterally and vertically, in comparison with the Niagara arch with its inclined ribs. A number of European arches, however, give quite as strong evidence of the greater rigidity of the inclined rib construction.

Two other things which also contribute to the rigidity of the Niagara arch are doubtless the employment of stiff members throughout for the lateral bracing and the adoption of riveted connections. While pin connections and tension laterals would probably have saved considerably in time and trouble in erection, it can hardly be doubted that they would have been much inferior in point of stiffness, and in a structure of such cost and magnitude it was unquestionably wise to subordinate such minor advantages to gain increased rigidity in the structure as a whole. It is plain that the wearing out of the Niagara arch by impact or by movement under load is a very remote contingency with the notable qualities of stiffness which it now exhibits under traffic. Indeed, there seems to be every reason to anticipate that the structure will be as capable of serving the purpose, barring injury by corrosion, a hundred years from now as it is to-day.

The proposition to support the bodies of freight cars on their side bearings as well as on their center bearings is somewhat startling and revolutionary, but it was brought up for discussion at the May meeting of the Western Railway Club and received some strong support as well as severe condemnation. The present universal practice is to carry the entire load upon the two center bearings, the side bearings being only provided to check rolling and lurching, and car specifications frequently lay stress upon the requirement that the side bearings must not be in contact even when the car is fully loaded. Among railway superintendents and car builders complaints are frequently made in regard to the troubles due to the fact that cars will and do settle on their side bearings. When a car is in this condition the friction between the ordinary side bearings is sufficient to check effectually the free swiveling of the truck, and sharp flanged wheels and badly worn rails are apt to result. Mr. A. M. Waitt, General Master Car Builder of the Lake Shore & Michigan Southern Ry., opened the discussion at the Western Railway Club, and advocated the normal distribution of the load between the center and side bearings, but pointed out that this would necessitate the use of roller or ball bearings, and that these bearings must be kept in free working condition. As the result of considerable investigation he found that a large proportion of cars are actually running with their side bearings in contact, and in tests made with a number of cars in the yard he found that on leaving a curve the trucks remain slewed, the flange friction being then so great that the cars would not run down a considerable grade. The trouble was greater on cars with trussed wooden bolsters than on those having metal bolsters. But with the cars of great carrying capacity now coming into extensive use it is difficult to make even metal body and truck bolsters which will permanently maintain their shape and keep the side bearings clear unless these bolsters are made very heavy. Now one of the advantages urged in favor of metal trucks is a saving in dead weight, and it becomes a question, therefore, whether to increase the weight of the bolsters or to carry part of the load on the side bearings, in which latter case the weight of the truck may be reduced. There are successful roller bearings in use, some of which have lever attachments which compel the rollers to move. Some of the speakers who opposed the distribution of the load advocated the use of the swing motion truck to make the cars ride easier and take the curves more easily, but in general the car departments are opposed to this form of truck. Considering that with cars of 60,000, 80,000 and 100,000 lbs. capacity, having bodies weighing 15,000 lbs., we have a load of 37,500 lbs., 47,500 and 57,500 lbs., respectively, concentrated on each center plate, it would seem, mechanically, the better plan to distribute these loads, but there are many practical objections to doing this. The question is one of importance, and is likely to be heard more of in the near future.

We advise those of our readers who may be interested either in air brake design or in patent law to secure a copy of the Patent Office "Official Gazette" of May 17, which contains the decision in full of the Supreme Court in the case of Westinghouse vs. Boyden, which we briefly noted last week. The decision occupies 16 pages of the "Gazette," including the dissenting opinion delivered by Justice Shiras. The case is undoubtedly one of the most important patent suits from a legal as well as a commercial point of view that has ever been decided by the courts. It is conceded by all parties that Westinghouse was the first to make a practical success of the application of the air brake to long trains of freight cars, and he is therefore admittedly deserving of all the privileges which the law accords to a pioneer inventor. But when Mr. Westinghouse attempted to protect his great invention by a patent, the task was found to be a peculiarly difficult one. Of course the obvious method of obtaining a broad protection was to patent not the particular apparatus employed but its function. In this case the function was the admission of air from the main train pipe directly into the brake cylinder for an emergency application. In Westinghouse's original application a broad claim for this method of operation was made, but the Patent Office found that a former air brake patent (Boyden No. 280,285) had admitted train pipe air directly to the cylinder, though not for the same purpose. Mr. Westinghouse's solicitor therefore was obliged to abandon the claim for a method or process and limit the claim to a certain combination of mechanical elements. In the interpretation of this claim the Court holds that Westinghouse is to be adjudged a pioneer inventor and entitled to the benefit of the doctrine of mechanical equivalents. That is to say, any one infringes his invention not only if he makes use of the exact combination set forth in the pioneer inventor's claim, but also if he makes a combination in which mechanical equivalents are substituted for some of the elements of the combination covered by the pioneer patent. The question was then reduced to this: Did the Boyden triple valve in suit employ mechanical equivalents to the elements set forth in Westinghouse's claim? (No. 360,070). The Court gives a lengthy discussion of this question, which is of course impossible to follow without models or drawings of the respective triple valves, and concludes by saying:

Conceding that the functions of the two devices are practically the same, the means used in accomplishing this function are so different that we find it impossible to say, even in favor of a primary patent, that they are mechanical equivalents.

The dissenting opinion by Justice Shiras holds broadly that the improvement which Westinghouse is conceded to have made in the air brake is so great that the law should be so construed as to protect him in it. He holds that notwithstanding the limitations which prior existing patents compelled him to insert in his specification and claims, he is entitled to have his patent cover the method or process by which his results were attained, and that even if he is limited to a claim for the combination of mechanical elements this claim should be so broadly and liberally construed as to make the devices used by Boyden a mechanical equivalent for the elements set forth in the Westinghouse claim.

The bill providing for a national commission for the arbitration of disputes between railway companies and their employees, recently passed by both houses of Congress, appears to be a very creditable measure, and while by no means so radical as has been advocated by many parties, it is free from the very serious objections which attach to any proposition for compulsory arbitration. Briefly, the bill provides that either railway companies or employees may request the Chairman of the Interstate Commerce Commission and the Commissioner of Labor to endeavor to settle a pending dispute amicably by mediation between the contending parties. In case the endeavor fails, each party to the controversy is to name one arbitrator and the two so appointed shall select a third, and the board so chosen shall make an award within 20 days from the time the third arbitrator is selected. The award shall continue in force between the parties for one year, and the employer shall not dismiss nor shall any employee dissatisfied with the award quit work under three months without giving 30 days' notice.

The only force relied upon to cause either party to take advantage of this system and to abide by its results is the force of public opinion, which is, after all, the real force behind laws of every sort. It is believed that few railway companies or labor organizations would venture to encounter the public disapproval that would follow its refusal to submit its case to arbitration, or the still stronger expression of public sentiment that would follow a failure to accept the result of an arbitration.

The Philadelphia Electrical Exposition, which we briefly noticed in our last issue, is to continue from June 6 to July 6, instead of from June 3 to June 10, as we stated. The error resulted from the ambiguous wording of the complimentary invitations sent out by the exposition management.

THE PROPOSED NEW CHARTER FOR THE CITY OF SAN FRANCISCO.

Unlike most of the states of the Union, California, through its constitution, has vested in its cities the right to frame their own charters, subject to the veto power of the legislature. This right has just been exercised at San Francisco, where, on May 26, the date of our present issue, the people will vote on the adoption of a new charter, some features of which are described elsewhere in this issue.

If the San Francisco charter as drawn ever goes into effect it will be a unique document in respect to the powers of direct legislation conferred upon the people. Aside from the fact that the people, through 15 freeholders elected for the purpose, have framed their own charter, the instrument provides that they may amend it without appeal to the legislature; may pass ordinances without the intervention of the supervisors, or city council; and that certain acts and ordinances of the supervisors must be submitted to the people for approval and rejection, while certain other ordinances must be subjected to popular vote if demanded by the people.

This charter, including both the provisions cited and the methods by which it has been framed, cannot fail to interest the already large and rapidly growing class of thinking men who believe that the interference of state legislatures in purely local affairs is one of the greatest evils of municipal government in the United States. That this interference should be so marked is all the more strange when it is remembered that it affects so large a proportion of a great nation which in its earliest history fought long and desperately for the fullest measure of self-government. The causes for this condition and the dividing line between local and state affairs we shall not attempt to discuss.*

It is to be hoped that the San Francisco charter may go into effect and be given a fair trial, as it is highly desirable that we should know what a great American city would do if possessed of such large legislative powers as to make it practically free from the state legislature in purely local concerns, while at the same time the exercise of this freedom rested, at least in theory, directly with the voters. It is true that the charter provides that "the legislative power of the city and county shall be vested in a legislative body," known as the supervisors, consisting of 18 freeholders chosen from the city at large. But as voters equal in number to 15% of the votes cast at the last election can at any time petition for an election to vote on an ordinance, or on amendments to the charter, the exercise of very full legislative powers by the people depends only on the possibility of their working together for that end.

Large powers of local legislation are practiced in England, and with remarkably good results, but so far as we know this is done through representative bodies, like town and city councils. The New England town-meeting has been for centuries, and still is, a popular legislative body, but its functions were for many years simple, and as they have been enlarged and complicated the powers of the town and the manner of exercising them have been pretty clearly defined, or at least outlined, by the legislature. Moreover, with growth in population and activities the New England town-meeting system has become more and more cumbersome, and the government assumed an increasing representative character, until one town after another has changed to a city organization and the town-meeting become a thing of the past.

But the San Francisco charter provides nothing like the town-meeting system. It gives the people representative government, with powers to change the form of that government by amending the charter, or the legislation passed by its representative body by framing and adopting popular measures. The New England system was one of compulsory popular government; the San Francisco plan is permissive, recognizing the necessity of representative government in a large city, but retaining popular control.

The power of direct, popular legislation, and of amendment of the charter, would take away a large part, at least, of all occasion for legislative interference in local affairs. Changes in policy or methods are thus decided directly by the community interested, and not by legislators from distant localities. Moreover, if a change be made, it can be effected only by a majority of those having interest enough to vote on the question at issue, instead of a few men with influence enough to insure or defeat any legislation they or others may propose.

There are, of course, some dangers and inconveniences in popular legislation of this kind. Those who fear them can avoid them, and at the same time greatly improve existing conditions in many cities, if they will merely give local legislative bodies as full legislative power as is consistent with their duties and the conditions under which they exist. It will then rest with the people to choose proper representatives, a thing they are likely to consider more carefully if they know that they cannot run to their state capitol to secure remedies for the evils arising from electing city aldermen who are unfit to be trusted.

Having considered the legislative powers vested in the people a few other features of the charter may be discussed. There will be over thirty different offices to be filled at each election. This is a large number of names to put on a ticket. If a man discriminates between the candidates of the different parties he may have to choose from 60 to 90 names, or even more if there are three tickets. Comparatively few voters can have any personal knowledge of the capabilities of so many candidates. The difficulty might be lessened by giving some of the officials a longer tenure of office than two years, the term of all but five of them, and by having some of these elective offices appointive instead. The mayor is given the power of appointing 33 officers. He can also remove all appointed officers, for cause, and suspend all elected officers, except the supervisors, the latter having the power of removing elected officers suspended by the mayor. This centers large responsibilities in the mayor, which many believe to be an essential of good city government. Some of the most important appointed officers are limited in many of their powers and duties by ordinances passed by the supervisors, who are elected by the people, while the people themselves may pass ordinances affecting these appointed officers.

The three commissioners of public works are given administrative charge of nearly all the property and public improvements of the city, except the park system. Each commissioner has a yearly salary of $4,000, in return for which he must give all his time during business hours to the duties of his office. The salary is none too high for the position, especially with the condition named, and doubtless the many duties of the board will demand the whole time and energies of its members. There are no provisions in the charter regarding the qualifications necessary for membership in the board of public works, an attempt to provide that one member must be a civil engineer of ten years' practice having failed of success. There is much to be said in favor of having at least one engineer on such a board, as so many of the questions involved are of an engineering character. The mayor can appoint an engineer as a member of the board if he sees fit, or he may select all the members from that profession. Few would think it wise to compel the latter, and there are reasons why the whole matter may well be left to his discretion. As a general rule, we strongly approve the plan of having at least one engineer member of all public boards dealing largely with engineering questions, but to make it compulsory is another thing. The San Francisco charter provides for a city engineer

*The subject in its various bearings is full of interest. Those who desire to add to their information on it and on municipal government in general can consult with profit "Municipal Home Rule" and "Municipal Problems," by Frank J. Goodnow, and the "Study of Municipal Government," by Mr. Delos F. Wilcox. For descriptions of the frame of government of a number of American cities, with comments on the same, and with many papers by various city officials and reformers, reference may be made to the reports, some three or four in number, of the recent conferences on municipal government, published by the National Municipal League, 514 Walnut St., Philadelphia, Pa. For descriptions of city government abroad, from which much may be learned, the standard works are "Municipal Government in Great Britain," and "Municipal Government in Continental Europe," by Dr. Albert Show.

who is to have charge of all the work of the board, and this is perhaps as far as compulsion should go in the matter.

The position of the city engineer under the charter is not so dignified as its importance demands. The necessity of such an officer is recognized, but he is too much a mere servant of the board, not even having the power of appointing his own assistants, and being removable at the will of the board. In some respects it might be better for the mayor to name the city engineer, but there are also reasons why the board should appoint him. No hard and fast rule can be laid down for general application in such matters.

It seems inconsistent that the framers of the charter should have refused to require that one member of the board of public works should be an engineer, while at the same time requiring that all the five appointed members of the board of health should be physicians. There is perhaps some excuse for this requirement in view of the fact that the board of health is to have charge of the city hospitals, but this alone is insufficient to warrant the absolute exclusion of lawyers and engineers from the board, to say nothing of other classes of professional and business men. Anyone intimately acquainted with the work of a municipal health department knows that the questions arising for its solution are pretty well distributed between medicine, engineering, law, and what may be termed business.

The charter specifically provides that garbage disposal shall be under the sanitary supervision of the board of health. Besides this, the sanitary phases of water supply, sewerage, street cleaning, and the heating, ventilating and plumbing of buildings will, or should, be under the control of the board of health. These are questions for the engineer to consider, rather than the doctor, so that if the charter is to limit appointments to the board of health to the professions best qualified to act upon the questions to come before it there is fully as much reason for appointing engineers as doctors upon the board.

Regarding the provisions of the charter which relate to franchises, we have only commendation to offer of the main principles set forth. We have often expressed our belief in setting firm limitations on franchises and in municipal ownership (which does not necessarily mean municipal operation) of "public utilities," as the charter calls water supply, lighting and similar works. How the plan provided for the gradual acquisition of these public utilities will work, only experience can determine. Doubtless, it will meet with strenuous resistance from those having pecuniary interest in existing or prospective franchises. Possibly the desire to prevent the carrying out of the plan will result in making questions of public ownership overshadow others of importance in the city elections; but this must be the case however these questions are settled. The main thing is to give the people a fair chance to decide for themselves between public and private ownership. The battle will doubtless be waged along that very line on May 26, when the voting on the adoption of the charter takes place, and unquestionably it will be renewed on this line if the charter comes up for approval in the state legislature. The charter once in effect it seems as though it would be impossible to prevent the people from carrying out whatever policy regarding municipal ownership the majority may desire, since the people may demand a popular vote on the subject at any time.

In conclusion, good government is a matter of men as well as methods. However satisfactory the San Francisco charter may be in theory, indifference or unreasoning partisanship on the part of the voters will result in bad government. No system of government nor forms of election can ensure that only capable and honest men shall be chosen to places of public trust and responsibility. The San Francisco charter, however, notwithstanding minor defects, seems to have the large merit that it leaves much power in the hands of the people, and provides means whereby public opinion may effectively neutralize the work of corrupt officials and carry out any needed popular reforms whenever their need is so great as to bring a strong majority to their support.

THE MANAGEMENT OF NON-PARALLEL MOTION AND DEFICIENT OPERATING HEAD IN BEAR TRAP DAMS BY AUXILIARY CONSTRUCTIONS.

All recent studies of bear trap dam design have given much prominence to the statement that the two great problems which remain to be solved before the use of such barrages can be extended generally to wide openings for navigation are: (1) That of providing an initial operating head ample under all conditions, and (2) that of securing operation without non-parallel motion or warpage of the dam. Two different methods of solving these problems are likewise commonly suggested by engineering writers. The first of these is to use auxiliary constructions, and the second is to secure the necessary power and regulation by purely constructive features of the structure itself.

In the great Chicago Drainage Canal bear trap and in the Marshall bear trap, so fully described in this and a preceding issue of Engineering News, the engineers have adopted the solution of auxiliary constructions. As these structures are, in the one case, the largest bear trap in the world, and in the other case the latest design of an engineer who has devoted years of study to the problem of bear trap dam construction, a brief examination of the reasons which led to the use of auxiliary power will be interesting. In a great measure the articles describing these two dams have considered this question, but it will, perhaps, aid to a clearer comprehension if we present the more salient considerations by themselves and free from the mass of detail which the descriptive articles involved.

Taking first the Drainage Canal dam, it is evident at once that it stands apart from previous dams of the same type, first by its great size and weight, and, second, by its auxiliary constructions, (1) to supplement deficiencies of operating water head, and (2) to secure parallel and undistorted operation. These features, in their various phases of significance, chiefly demand attention here. That there may be no confusion in this consideration, we may with advantage pass by the more general questions of theory of operation, and proper proportioning of leaves and angles, with their attendant mathematical discussions, assuming, as is reasonable, that they were properly considered. It is also unnecessary, in view of the very full discussion of that point in the preceding articles, to enlarge upon the reasons which led to the selection of a bear trap dam as a part of the Drainage Canal regulating works. Our study of the structure is then confined to its mechanical design and its auxiliary constructions to meet the problems and difficulties of practical operation.

It would be incorrect to assume that the Drainage Canal bear trap is the first instance in which these problems have been encountered, for their possibility has been recognized for years, and, in fact, actual exemplifications of their existence are found in structures of this type already built. To aid to a clearer understanding of the Drainage Canal structure we may revert briefly to these previous experiences. Before doing this, however, it should be noted that the Drainage Canal dam is larger than any other dam of the same type ever built, and, being constructed of steel, it follows that its weight is so much more greater than that of smaller dams constructed of wood. A definite comparison of the size of the Drainage Canal bear trap and others of importance is afforded by the accompanying table, but the real importance of this large size in this dam, is that it is chiefly responsible for the problem of providing supplementary mechanisms to overcome deficient water head and non-parallel motion, such as have been comparatively little used in previous dams.

Table Showing Dimensions of the More Important Bear Trap Dams Constructed in the United States, Compared with the same Dimensions of the Drainage Canal Bear Trap.

Name and location.	Lgth, ft.	Hght, ft.	Form.	Material.
Davis Island, Ohio River.......	52	9.33	White.	Wood.
Dam No. 1, Monongahela River.	130	9	Du Bois.	"
Menominee R., Menominee, Wis..	14	7	Parker.	"
Milwaukee R., Milwaukee, Wis.*	23	14	"	"
Muscle Shoals Canal, Tenn. R.	40	8.5	"	"
St. Croix R., Nevers, Wis.†...	80	14	Lang.	"
Miss. River, Little Falls, Minn.	60	7	"	"
Chippewa R., Little Falls, Wis.	58	12	"	"
Chippewa R., Chippewa Flls, Wis	80	6	"	"
Sandy L. Reservoir, Minnesota§	40	13	"	"
Drainage Canal bear trap......	160	..	......	Steel.

*Two dams of this size. †Also one 24x14 ft. and one 20x14 ft. §Also one 11x12 ft.

Perhaps the most serious trouble from non-parallel motion is found in the record of experience with the Du Bois bear trap erected in the Monongahela River, and known as Dam No. 1. This dam is also notable as approaching most nearly in length that for the Drainage Canal. The Monongahela River dam had its filling and discharge culverts in one pier only, and according to a recent statement by Mr. William Martin, U. S. Assistant Engineer, the warpage was so great that the end next the filling culvert came up about 5 ft. in advance of the opposite end, and again in lowering the same end was in advance the same distance, making a variation of 10 ft. in the crest. The evil effects of this fault are obvious. As a matter of fact the designer endeavored to correct it by the use of a rack and pinion mechanism at the ends of the leaves, but owing, it is stated, to improper design this attempted remedy was not successful. While this experience was an evidence of the danger of warpage it unfortunately was not conclusive evidence, for the obviously improper construction of the culverts in the light of more recent practice, and probably other faults of design, left it undecided whether a more scientific design and more careful construction would not have prevented the trouble. The same argument has been urged in other instances of twisting dams, and in the most recent opinion on the question are found diametrically opposite beliefs, with no conclusive data to prove the correctness of either.

Similarly to the parallel motion device we find a forerunner of the elaborate counterweight system of the Drainage Canal dam in the 40-ft. bear trap at Sandy Lake Reservoir. Here when the head is so small that it will not raise the leaves provision has been made to raise them by means of a system of air bags and also by a windlass. It is needless to enter into the details of this construction here, for the main point to be noted is that a deficiency of an operating water head under certain circumstances is not a condition peculiar to the Drainage Canal structure alone. Neither should it be understood that the structures particularized above are the only ones exhibiting similar conditions of possible deficient water head to operate the dam, although it is doubtless true that in some cases improper design and construction are largely responsible for the existence of the condition.

The experiences with the Monongahela River and Sandy Lake Reservoir dams demonstrate the fact that in the two respects noted no formerly unknown conditions nor constructions are presented in the Drainage Canal dam, however unprecedented these last constructions may be in magnitude and elaborateness. Having set our ideas straight upon this fact, we may ask what further significance these previous experiences have for the engineer designing a similar structure. Obviously they warn him as to the possibilities of certain difficulties which will have to be provided against under certain conditions. This being the case, conservative engineering practice demands that we ascertain whether these experiences are logical from the point of view of practical mechanics.

The bear trap dam belongs to that class of structures which utilize the velocity head of running streams and the static head of dammed water for their operation. Theoretically the slightest head will produce motion, but practically allowance must be made for friction, inertia, excess in weight of gate, dynamic effect of swiftly passing water and various other things, all of which take a surplus of head to overcome. A deficiency of the water head necessary to operate the dam is then a logical possibility. Moreover, assuming that the application of the operating water pressure is theoretically perfect, it is evident from the mechanics of the bear trap and its operating power that the relation between the resisting forces and the actuating forces varies at each position of the dam in ascending from its lowest to its highest position, and vice versa. A perfect application of the auxiliary power, which is designed to aid the water head in operating the dam, is consequently one in which this auxiliary power varies from position to position of travel proportionately with the variation of the relation between the primary actuating and resisting forces.

It was assumed above that the application of the operating water pressure was theoretically perfect; that is, that at each stage of the travel of the leaves the water pressure against their under sides was uniform upon every unit of length having theoretically the same vertical height. Still retaining this assumption, non-parallel motion may result from the fact that inequality of resisting forces (friction, weight, inertia, etc.,) per unit of length exists. As an illustrative example, suppose the resisting forces to be 5% less over one-half of the dam than they are over the other half. But uniformity of application of water pressure is not possible to obtain; it can only be more or less closely approximated. The whole question as to the possibility of preventing non-parallel motion then simmers down to this: Can the pressure of the actuating force (water pressure) and the intensity of the resisting forces (weight, friction, etc.,) each be divided evenly per unit of length of the dam by constructive carefulness alone? Obviously they cannot be divided perfectly. Whether they may be divided with sufficient perfection to avoid serious trouble depends upon the intensity of the actuating and resisting forces and their area of action, and the longer and heavier the dam the greater these become. At some length of dam the point must necessarily be reached where supplementary constructions are more practicable to prevent distortion than the refinement of constructive carefulness alone. Non-parallel motion unpreventable by practicable perfectness of construction then seems to be a logical possibility.

It will be understood that the foregoing discussion is not presented as something novel, but is intended merely to suggest the basis of practical experience and reasoning which led to the adoption of the elaborate auxiliary operating mechanisms for the Drainage Canal bear trap, which have been described and illustrated. Such a suggestion seemed to us to be desirable in view of the frequently expressed opinion that the remedy for operating defects, and non-parallel motion particularly, lies, not in additional mechanism, but in correct design and careful construction. This opinion was formed from experience and study of short length wooden dams having a specific gravity not much above unity; far different structures, it will be seen, than the 160-ft. steel dam having a specific gravity some seven times unity, which is being constructed for the Chicago Drainage Canal. Under other and different conditions it is quite likely that these same supplementary mechanisms might be unwarranted.

These supplementary mechanisms have already been fully described, and all that is needed here is a brief summary of the salient features. To furnish power for deficient water head a system of counterweights is used and so designed that it supplies a variable power at different stages of the travel of the dam. To prevent warpage the construction has been designed (1) to distribute as uniformly as possible the resisting forces per unit length of the dam; (2) to reduce leakage and to admit the water by means of a large number of vertical vents, that is to distribute the water pressure; (3) to provide against all lack of uniformity in resisting and actuating forces which might result despite these purely constructive precautions by means of an elaborate parallel motion mechanism.

It cannot be stated certainly what the success of these constructions will be for the purposes for which they were designed. What the probabilities for their success are each one can study out for himself. It has been the purpose here simply to show upon what records of past experience and upon what basis of reasoning in practical mechanics the use of these structures at all has been founded. The Drainage Canal bear trap was too important and too costly a structure to permit of any risks being taken upon its failure to operate. Rather the conditions demanded that the precautions to insure perfect operation should be excessive, even at considerable extra labor and cost. To its designers it seemed that the lessons taught by past experience and the logic of mechanics were lessons of caution against certain possible failures of operation, and they recognized them in their designs. That they were justified in doing this we believe most engineers will admit; but, be that as it may, it is plainly evident that in the Drainage Canal bear trap and its supplementary constructions engineers will be afforded an opportunity to secure valuable evidence upon several more or less doubtful features in the practical operation of bear trap dams. At the worst, it will stand as the most elaborate attempt yet made to secure a perfect structure of its type, and among all the problems evolved in the construction of the great waterway of which it is a part it ranks as the one most difficult in solution.

The Drainage Canal dam, however perfect it may prove for its present duty, is obviously not well adapted for a navigable waterway, which is the office for which the Marshall dam is particularly designed. It is, however, a matter of doubtful propriety to speak of this structure as a bear trap dam, as it resembles certain forms of wicket dams quite as closely as it does the conventional bear trap. The points we need to observe particularly here, however, are the provisions made to secure parallel motion and to supply the initial operating head. The designer evidently hopes to find a solution of the first of these problems in the sectional construction and in the method of taking the pressure for positive operation direct from the pool, thus doing away with the danger of a scant and non-uniform supply of water furnished by a more or less tortuous system of supply culverts. To secure even operation, therefore, this dam depends purely upon its design and the perfectness of construction. On the other hand, to supply the possible deficient operating head a wholly auxiliary construction is adopted.

So far as we are aware no dam of this construction has yet been erected, and until this is done the design cannot be said to have its merit fully established. It is, however, an exceedingly simple construction, and so far as can be determined without a full mathematical investigation, which we have not made, it seems to be correct in its mechanical design.

LETTERS TO THE EDITOR.

Shall We Rely on Engineers' Tests or Manufacturers' Reputations?

Sir: While there is no doubt that it is desirable to apply physical and chemical tests whenever practicable to all sorts of supplies, there are still many cases where the chief security to the purchaser lies in the manufacturer's reputation; and the instance mentioned in your editorial columns of May 19 is a case in point. It is an unfortunate example of a "rigid test;" an analysis which gives the percentages of oil, turpentine, red lead and chalk by bulk does not convey any intelligible idea to me—and I suppose it will be admitted that I am an expert in the paint business—of its composition; and I do not think a paint manufacturer could, from such an analysis, compound a paint which would not vary at least one-third in some one ingredient on subsequent analysis. It would be possible to make an analysis of a red lead paint giving percentages by weight which would mean something.

Second, the analysis was really uncalled for; everyone who has given any attention to the matter during the last four hundred years—for the use of red lead as a paint dates from the dark ages—has known that red lead and linseed oil form a quick-setting cement; a "ready mixed" red lead paint must contain a large amount of something else to prevent it from setting; and the man who will buy such an article when he wants pure lead and oil would be liable to buy Portland cement ready mixed with water. What we need is not a law to protect the engineer from the supply man, but one to protect the employer from the engineer.

Third, the inference which will be drawn from your quotation that the analysis of commercial chemists are not reliable is in general wrong. There is as large a proportion of skilful and conscientious men among them as in any other profession. I send work to commercial chemists frequently, and have never had occasion to doubt the accuracy of their reports. It is, however, easy to fix a sample for analysis before it is sent.

Fourth, if you will draw up a list of adulterants for paint I will be pleased to criticise the same. I doubt whether many, perhaps none, of the things used in paint and varnish have not a legitimate use. I am not sure that turpentine and whiting are adulterants of ready mixed red lead; it is physically impossible to make such an article without something of the sort, and a necessary ingredient is not an adulterant. If the man who is to make satisfactory chemical analyses of paint and varnish has been born yet—I hope he has—at least he has not yet acquired the necessary knowledge; and the most that can be done in many cases is to verify the goods supplied with the sample previously submitted. After all, in this age of specifications and inspection, there is nothing like an honest and capable contractor. Get him, if possible, and then watch him. This is eminently true of the supply man.

Respectfully yours, A. H. Sabin,
45 Broadway, New York city, May 21, 1898.

Credit for the Design of the New Holyoke Dam.

Sir: I do not care to follow Mr. Waters through the mazes of extraneous matter which he injects into his letters to your paper of April 28 and May 19. I propose to stick to my subject. His attack on me has grown out of this statement by me in your paper of April 14: "The Holyoke Water Power Co. is spending a large sum of money in the construction of the stone dam designed by me as a preliminary study for that work in 1885." (See Trans. Am. Soc. C. E., 1886, p. 576.) To this he replies (Eng. News, April 28) that when he, as the hydraulic engineer of that company, was called upon to construct the dam, he had in mind his plans for two stone dams designed in 1867 to be built in Connecticut and adopted a similar profile, and the plans for the Holyoke dam were not based upon any of my preliminary studies for such work "and do not resemble them, excepting that all ogee-faced dams have what might be called a family resemblance." I suppose twins sometimes have what might be called a family resemblance, and two photographs of the same person, taken from different points of view, are afflicted in the same way.

I called for the cross-section of these mysterious 1867 dams April 28, but in Mr. Water's rejoinder, in your issue of May 19, we hear nothing further of them. Instead we are treated to a dissertation about the front face, not the cross-section, of a lot of dams mostly built since 1885, all the rest, both drawn and named in the text, with no bearing on the subject, being little, drowned weirs in the originals; and all this, for the purpose of proving that immaterial proposition, which nobody disputes, that the front faces of ogee dams have a "family resemblance," especially when the one has been made by slightly modifying the other.

Again I propose to stick to my subject. Mr. Waters knew when he wrote his articles, or he should have known, that I was appointed in 1885 on a commission of three to present plans for the Holyoke dam. He knew, or he should have known, that I presented my design as a minority report, the other design presented being a step dam, made of huge monoliths, measuring about 12 ft. × 4 ft. × 3 ft., and weighing 12 to 15 tons each, to use which it was proposed to construct special derricks in the quarry and on the works and special cars to transport them. He knew, or he should have known, that the experiments I made with the majority and minority report cross-sections convinced the directors of the company, and even the majority of the commission, that the minority idea of dam construction had been the correct one; and he knew, or he should have known, that their favorite design having thus been rejected, the majority of the commission then consented to the modification of my design, which constitutes Mr. Waters' dam No. 4 in the diagram of dam sections accompanying his letter published in your issue of May 19, which No. 4 he represented as having been made independently of my design.

In 1885 I stood alone as the advocate of the form of dam I then designed. It took many years of improving every possible opportunity for me to acquire proof that my 1885 ideas on the subject were correct; this proof I exhibited in Engineering News of Nov. 10, 1892, and April 14, 1898. With this history on the subject to refer to, I would indeed be craven to now allow anyone to step in and deny me recognition. Mr. Waters came on the scene in 1887. He says himself that he received a copy of my paper on the Holyoke dam from a director about 1888. But he claims that when he studied it he did not read it for the "purpose" of learning what was in it, and even if he had accidentally learned, he forgot it again. Knowing, or being in position to know, of all my hard-earned services in this matter, he proceeds to build or to attempt to build a dam on plans so nearly like my preliminary plans that the differences do not obscure the origin of the plans, and then calmly ignores this source, in printed and private communications, for years, until he has presumably come to actually believe what is not true.

I have thought this much might be useful for the guidance of those who care to know the history of this incident in the development of the construction of overflow dams in the United States on river bottoms liable to erosion, and appealing to the sense of justice of those who are interested in this subject, I propose to say no more upon it.

Clemens Herschel, Hydraulic Engineer.
2 Wall St., New York city, May 20, 1898.

Notes and Queries.

F. H. C. asks for information concerning the "pull" of a silk or hunting flag, expressed in terms of weight, wind velocity and square feet of flag, counting one or both sides. The change of wind direction should also be considered, as this causes the flag to "whip" and exert a momentarily greater pull. We submit the question to any of our readers who may have studied this somewhat novel problem.

CANTILEVER BRIDGE OVER THE THEISS RIVER AT TOKAJ, HUNGARY.

The structure which is shown in the accompanying illustrations will attract the attention, we are sure, of all our readers interested in bridge design. We are not so sure that any of them will make haste to copy it; but it is certainly worth knowing to what lengths Old World engineers can go in their worship of riveted construction. The bridge is not a mere drawing board fantasy, as some of our readers may conjecture, but has been actually erected. Still more remarkable, the design was selected as the best in a public competition.

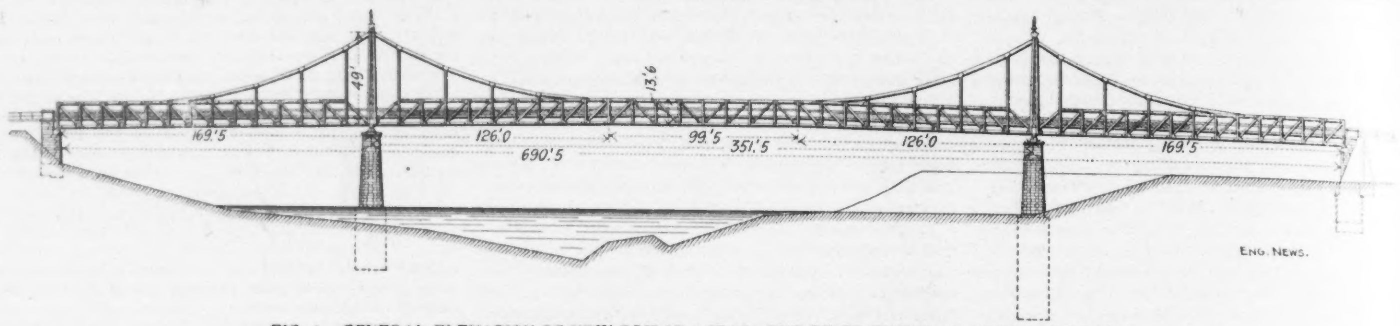


FIG. 1.—GENERAL ELEVATION OF NEW BRIDGE ACROSS THE RIVER THEISS AT TOKAJ, HUNGARY.
Robert v. Totth, Engineer Resiczca Iron Works, Designer.

Our illustrations of the structure are reproduced direct from our Austrian contemporary, the "Zeitschrift des Oesterr. Ingenieur und Architekten Vereines," except the general elevation, which has been redrawn by our own drafting staff. The designer of the bridge is also the author of the article describing it, which is published by our contemporary, and we shall leave to him the task of explaining the peculiarities of his designs. The following is a careful abstract of his paper, which has been translated for us from the German by Mr. O. J. Marstrand, M. Am. Soc. C. E.:

Toward the latter part of 1894 the Royal Hungarian Ministry for Commerce opened a competition for a bridge across the River Theiss, near the city of Tokaj, and among the plans submitted those of the firms of G. Gregersen & Sons and the Resiczca Iron Works were selected. Mr. Robert v. Totth, the author of this description, was engineer to the last-named firm, and had charge of the designing and construction of the superstructure.

The bridge, built in three spans, has two cantilevers, each 90.3 m. (296.27 ft.) long, and a suspended center truss, with parallel chords, 30.4 m. (99.74 ft.) long. The total length of the center-span is 107.6 m. (353.02 ft.), and of the side-spans each 51.7 m. (169.62 ft.) The clear width between trusses is 13 m. (47.2 ft.). While basic steel is generally preferred for Hungarian bridges, certain circumstances made it in this case advisable to use wrought iron, and it is of interest to note that the requirements as to punching and subsequent reaming of rivet holes were the same for both materials.

By adopting the novel design for the cantilevers shown in the illustrations, the author has arrived at a truss statically determinate, in which he could carry out the European preference for riveted connections at all joints. The cantilevers are composed of three chords; the two lower chords being parallel and made up of stiff members, while the top chord, extending only over ten panels of each arm, is made of bars. In all cases the cross sections are so determined that the center lines of adjoining members intersect in one point. The two parallel chords are braced by stiff verticals and diagonals, forming together with these a simple truss, suspended from the top chord at every other panel point. The iron towers are rigidly connected to the adjoining members, and form a part of the system.

The trusses rest on rockers, both at the piers and at the abutments. The rockers on the piers rest, again, on nests of rollers, while those on the abutments have fixed seats. There is no cross bracing, except that furnished by the portals over the piers. The two main lower chords of the cantilevers, and also the diagonals, have box-shaped cross sections, while the cross sections of the top and bottom chords in the suspended truss are T-shaped.

At one end this truss is fastened by a pin to the bottom chord of the corresponding cantilever arm, while at the other end it is suspended through pendulum bars from a pin resting upon the end of the top chord of that cantilever. This latter arrangement provides for temperature changes, taking effect from either side. The cross section of the middle chord in the cantilever trusses in the two panels next to the suspended truss is so changed as to facilitate connection with the curved top chord. The end panels of the top chords of the suspended truss are, of course, no part of the general system, and rest on the ends of the cantilever chords, to which they are bolted. The wind stresses are taken care of through a system of horizontal bracing.

A counterweight of masonry, weighing 81 tons, is placed under the floor of the end arms. It rests on rollers, and is carefully isolated from the truss system. The total weight of iron in the bridge is 700 metric tonnes (771.6 tons). This bridge was opened to traffic in November, 1896.

HYDRAULIC PLANT FOR COMPRESSING AIR.*

The term "hydraulic plant for compressing air" should be restricted to the cases where water is the main agent—i. e., to cases of the application of water power to the compression of air, and that is the sense in which the term is here used. The most usual way of applying water power to this purpose is to cause the water to produce rotary motion in some sort of a wheel, and by means of this rotary motion to drive reciprocating pumps in which air is received and compressed. This is obviously rather a roundabout process, involving the use of two distinct machines besides gear connecting them, and several conversions of energy. The consequence is that the net energy received by the pump piston is seldom more than half that of the original energy of the water. If, therefore, the power of the water could be applied more directly, we should expect to attain a great economy of power; consequently, many efforts have been made to secure this object. In the case of air-compression there is another reason for desiring the direct application of the power. All the work done in compressing air is converted into heat, but when air is compressed under such conditions that all the heat is instantly and entirely absorbed by surrounding solid or liquid bodies, only about half as much net work is exerted (if, for example, compression is to one-fifth of original volume) as when no heat is thus absorbed. Therefore, it is obvious that it is of the highest importance to thus absorb heat during compression of air. In compressing air in reciprocating pumps, it is found practically impossible to absorb more than half the heat which is developed. Hence the strongest reason for applying the water used for power directly to the air—that if it can be done it should result in very much more thorough absorption of heat than can be accomplished in any other way. This analysis of the imperfection of air-compressing machinery is, of course, modern, but the practical result—that the inefficiency was very great—has been realized in a rough way ever since compressed air has been in common use, and, therefore, the attempts to apply water directly have been many.

In this paper the author intends to confine his attention to those hydraulic air compressors which more or less perfectly attain this object. They may be divided into two classes: In that which will be mentioned first the compression is effected by the weight of a column of water of a height equal to the maximum pressure of the air measured in feet of water. To obtain this pressure the water used as power is carried down a well or shaft and up again in an inverted siphon. The air to be compressed is diffused through the water in bubbles as small as possible, and part of it is then carried down to the bottom of the well by the stream. That which arrives there is, of course, then subject to the pressure of the water column above it, and is accordingly compressed, and means are provided for allowing it then to escape from the water before it can again expand. This method is one of the very oldest known. One form of it is described by Pliny in the first century, and even then was old. In modern times several different inventors have revived it, and it is connected with the names of Upham, Mowbray, Frizell and C. H. Taylor. In this machine, as might be expected, the compression is isothermal, and it is a very simple machine and has few working parts. It is, however, rather an expensive one, as for a pressure of five atmospheres it requires the sinking of a shaft 150 ft. or more in depth, with an enlarged chamber and some of the apparatus at the bottom of the shaft. Moreover, it is found that the

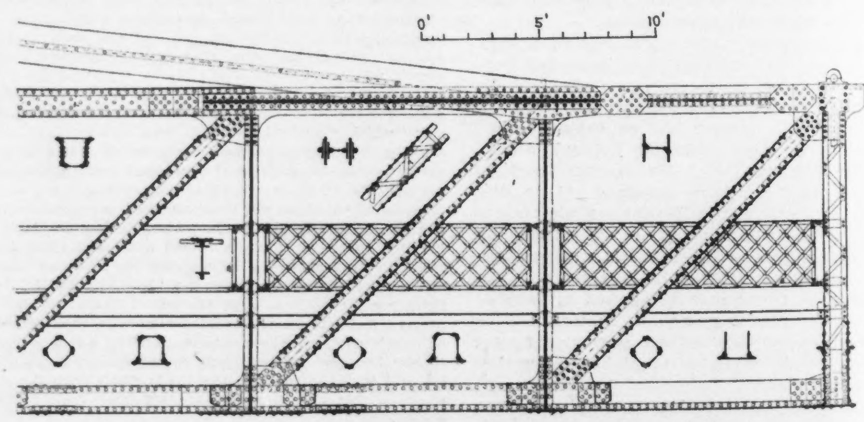


FIG. 2.—DETAIL AT END OF CANTILEVER ARM NEXT TO SUSPENDED SPAN, SHOWING "TOP CHORD" CONNECTION, THEISS RIVER BRIDGE.

*Condensed from a paper read by Mr. H. D. Pearsall, M. Inst. C. E., before the Manchester Association of Engineers.

unavoidable losses connected with it are large, so that its theoretical efficiency is not very high. These may be chiefly embraced under the head of fluid friction due to the flow through a pipe 300 ft. long and to eddies. The fluid friction is not merely that of water flowing through a pipe. The bubbles of air, although they descend with the water, do not descend as fast as the water. Consequently the water is all the time passing the bubbles, and the rubbing surface causing fluid friction is, therefore, the whole surface of innumerable bubbles of air, in addition to the surfaces of the pipe. The coefficient of friction is, therefore, very much greater than that of water in a pipe. The efficiency actually realized in practice appears to have been about 55% under the condition of using a very large pipe, a low fall and a pressure of only four atmospheres. Both a higher fall and a higher pressure diminish the possible efficiency.

In the other class of machines having the same object water acts as a piston, compressing the air in a chamber provided for the purpose. The earliest is probably due to Montgolfier, the inventor of gas balloons and of the hydraulic ram. The reason why it has failed to come into use is the same reason which for so many years has confined the hydraulic ram for water raising to machinery of small size, viz., the construction of the main valve, which was operated by the current of the escaping water. That this construction was unsuitable for any large size one supposes should have been obvious; but for one hundred years, in nearly all attempts to improve the ram, they insisted on retaining it. It was, however, abandoned in the application of this principle in the air compressor designed and used by Sommeiller in the excavation of the Mount Cenis tunnel. It consists of a pipe leading from the source of supply, two valves, a vertical pipe in which air is compressed, and a valve controlling the connection between this compression chamber and an air-vessel. The water does not act merely by its pressure. When it begins to flow, the air in the pipe offers very little opposition to it, and therefore the water acquires a high velocity and momentum. As the air becomes compressed it offers more and more resistance to the water, and this resistance absorbs the momentum of the column of the water. The compression is effected, therefore, more by the momentum of the column of water than by its pressure. Hence it is essentially an hydraulic ram. The head of water was 85 ft., and the air was compressed to 6 atmospheres. Notwithstanding numerous defects of designs, these machines had considerable success. Ten of them were made, and after they had been in use three years at the Bardonneche end of the tunnel, six others were made for the Modane end of the tunnel, where the fall was only 35 ft. In this latter installation a most remarkable course was adopted, the history of which is very instructive. The natural fall being only 35 ft., the water was first pumped by water-wheels to a reservoir at a height of 85 ft. and then used with this fall in the compressors. But a little consideration shows that this was entirely needless. If, instead of doing this, the valves had been worked in a different way, a fall of 35 ft. would have compressed the air just as well as a fall of 85 ft. The mean pressure due to compression to 6 atmospheres equals 61 ft. of water. When the fall was 85 ft. the water would give a mean pressure throughout the height of air column of 85 ft., less the loss of effect from fluid friction, etc. Hence if the efficiency was 75%, the flow of the water would be adequate to compress all the air above the level. The gross energy developed would evidently be represented by 85 ft. × height of air column. Now with a fall or head of 35 ft., suppose that after the chamber was emptied of water through the second valve, instead of then closing it before opening the first valve, the latter had been opened while the second still remained open. Water would then have flowed away through the second valve, and when the column had acquired a certain velocity the valve would be shut, and the compressing stroke would then take place. The energy available for compression would then be represented by length of column of water in pipe × head due to velocity + 35 ft. × height of air column, and it is evident that by making the velocity a certain amount—that is, by keeping the second valve open a certain time—the amount of this energy can be made exactly as great (or greater if desired) than the energy that was developed under 85 ft. head.

In 1891, the author described in a paper in the Proceedings of the Institution of Civil Engineers an engine of considerable size for pumping water on the principle of the hydraulic ram,* and then mentioned that he had also made experiments in compressing the air in the same manner. One of these engines has since been erected on the River Kent, in Westmoreland, from the author's design. This also consists of a pipe from the source of supply, and a chamber in which the air is compressed by the momentum of the water. But in this engine the method of using the water is that which the author suggested should have been used at Modane. The water runs freely away through the valve for a certain time, in order that it may acquire a certain velocity and momentum. The valve is then closed and the energy available for compression is exactly as the author already formulated it. Consequently, such an engine may be used on a fall, however small. In this engine there is only one valve in place of Sommeiller's two. The air valve admits a fresh supply of air into the receiver after the compression is accomplished, and also allows of the escape of some of this air while the main valve is closing, so that part of the water which flows in the main pipe during this time can rise freely in the chamber instead of having to find an exit through the narrowing orifice of the main valve. The valve is closed by the water when it reaches a float attached to a lever in connection with the valve. There being but one water valve, there is but little gear required to operate it, but it is necessary that the valve should open and shut at certain definite intervals of time. The power to operate the gear is taken from the air vessel, and from 15 to 20 strokes are made per minute. The working of this engine has fully justified the author's expectations. In the compression of the air practically all the heat developed is absorbed as it is developed. After several hours running the highest temperature shown was about 2° above that of the water. The engine runs with perfect smoothness and regularity without noise or concussions of any kind. The efficiency is very high, amounting to 80%—that is, the work done measured in isothermic compression of air is 80% of the gross power of the water.

*See Engineering News, Sept. 28, 1889; Sept. 22, 1892.

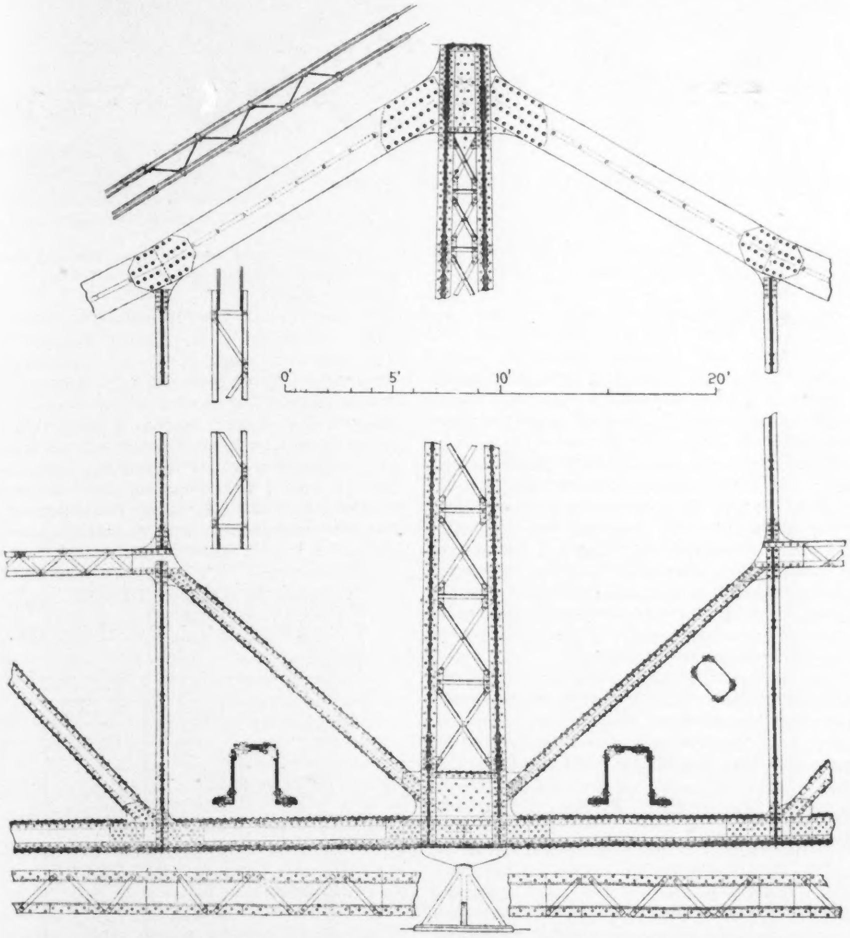


FIG. 3.—DETAILS OF "TOWER" BEARING AT PIERS AND "UPPER AND LOWER TOP CHORDS" OF CANTILEVER, THEISS RIVER BRIDGE.

A CASE OF JURISPRUDENCE IN LAND SURVEYING.*

A survey of a large and valuable tract of land was made under a contract substantially as follows. It was to include: 1. The establishment of a true north-and-south line at some suitable point on the property. 2. The survey of the outside boundary-line of the property, including the outlying lots. 3. The location of all houses, buildings, etc. 4. The principal features of the topography as far as the same are incidental to the surveys above mentioned. 5. A finished map of the whole work in all its details, on a scale of not less than 6 ins. to the mile.

The main tract was 11 miles long and about 4 miles wide, and of such irregular shape that its circuit measured about 44 miles. It was soon found that the courses and distances in the deeds of record on file in the county office were inaccurate and misleading, or were lacking altogether. There was no record of the date of the original surveys, nor any notice of magnetic variation at that time. The property itself was next explored in detail, and the country was found to vary from low swampy lands to sudden and extended elevations. Three lakes of considerable area and several ponds of varying size were included in the tract, and for the most part the country was thickly wooded. Deposits of rich magnetic ores were distributed here and there throughout the entire region, and it was soon discovered that their influence would be felt in the form of local attraction generally throughout the territory, and this became a serious and important facter in the work.

In due course the work was accomplished, the whole undertaking having consumed over a year's time. A total of over 300 miles of line had been run, surveys were calculated, acreage estimated, and a map drawn, being in scale slightly larger than the contract specified, and in all its features fulfilling the requirements. The map, when finished, was promptly delivered to the company, with a report describing at length and in detail the work that had been done and causes for the various delays in arriving at final results. A request made at this time by the engineer for a final and full settlement according to contract was refused, with the reply on the part of the company that no further payments would be made for the following reasons:

1. That the delivery of the map and results of the work were unreasonably long delayed, and had caused disappointment and embarrassment to the company. 2. That the lines run did not show on the ground the actual boundaries, and were misleading as to where the true lines of the property really stood. 3. That the contract bound the engineer to lay down on the ground the actual and true lines from corner to corner, after he had ascertained their position, by setting stakes and cutting a vista through the forest and underbrush. 4. That the true north-and-south line established on the property did not show the magnetic variation of the locality. 5. That where no corners were found, whether they had become extinct by natural causes, destroyed or removed to wrong positions, the engineer should have restored them to their proper place. 6. Though the map furnished was an artistic piece of work, bearing evidence of care and precision in its construction, and in all probability accurate at all points, yet it merely showed, theoretically, where the lines of the property were, and would not serve as a guide by which they could be traced on the ground. 7. That all notes, note-books, plots, papers, calculations, etc., of whatever nature, incident to the prosecution of the surveys, rightfully belonged to the company, and were wrongfully retained by the engineer.

In the engineer's protest against such an unjust view of the situation, he replied that the delay was caused by the difficulties encountered in the work, which were entirely beyond his control, and that the thorough methods em-

*Condensed from a paper read by Mr. A. E. Lehman before the Engineers' Club of Philadelphia.

ployed required time and every precaution to guard against error and hasty conclusion, while in the end all were for the company's benefit, and made at a constantly increasing expense to the engineer; that he was not legally bound to lay down the lines in their true position and cut a vista through the forest, which would have necessitated the doing of the work over again at almost the same cost of the original surveys; that a line had been staked out astronomically north and south, but, due to the local attraction, the angle of magnetic variation could not possibly be ascertained within reasonable time and expense; that where corner monuments were missing, because of doubtful authority conveyed by the records, the engineer was not bound to restore them, and had he done so without an agreement between adjoining property-holders, he would have assumed judicial functions clearly foreign to his duties; that the map furnished the company was an exhibition of the exact conditions found on the ground and the topography indicated would point to indestructible landmarks by which the boundaries could be traced; that as the whole work was done by contract for a stated sum, the engineer was bound to furnish only what his agreement called for; and he held that his methods and records belonged to him as long as results given were accurate.

This appeal of the engineer, in the end, brought about settlement in accordance with the contract; and when the balance due him was paid, and all salaries, wages, and expense accounts deducted, he found, in confirmation of his fears, that he had lost seriously on the work.

In closing, the author stated that however prejudiced our view might he in favor of the contention that the engineer could only fulfil his contract by restoring all boundary lines as originally surveyed in harmony with the courses and distances as given in the deeds of conveyance, yet such a view of the case must certainly allow the engineer, on his part, to demand that his employers provide him with a correct record of the field-notes of these surveys, showing where every position was taken by the instrument used, its character and equation, the length of every sight, etc.; for without this exact data it would be manifestly impossible for him to reproduce the original results or lay down the lines as they were before all signs of their position had disappeared.

THE MARSHALL AUTOMATIC MOVABLE DAM.

An automatic, and, it is claimed, a perfectly controllable dam of any desired length, has been devised and patented by Major Wm. L. Marshall, Corps of Engineers, U. S. A. As shown in the patent drawings, this dam belongs to the "bear-trap" type, with certain essential differences, among which is the very peculiar one that atmospheric as well as hydraulic pressure is utilized in working it. All working pressures also are exerted on the outside of the so-called "hydraulic" chambers, and are directed inward, except in a special case; and the dam is built in separate parts, with intervening piers closing the ends of the hydraulic chambers of the units, and projecting downward below the bottom of the river, instead of upward, as in the forms in use. Thus all forces acting upon the dam are directed downward and hinges become a much less important structural consideration than in the ordinary forms of bear-trap dams. In the old form of dam also an actual transfer of water into the hydraulic chamber precedes any movement of the gates; while in the new form pressure is transmitted

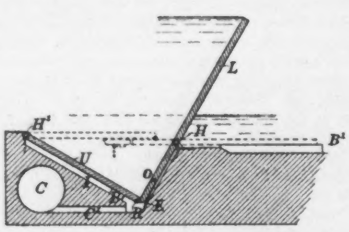


Fig. 1.—Cross-Section of Marshall Dam, Showing Leaf Raised.

instantly by the disturbance of a pre-existing equilibrium of forces, and the transfer of water into and out of the chamber is the consequence and not the primary cause of motion. As a result of this arrangement, the pressures on the gates, under similar conditions, are claimed to be absolutely uniform for similar areas or positions, and there is no tendency to twist the gates, except in the case of unequal resistance from friction.

In referring to the drawings, Figs. 1, 2 and 3 show a downstream leaf L, hinged to the foundation at H H near the center of fluid pressure on this leaf, and forming a cantilever. An upstream leaf U is hinged to the foundation at H^1, and the free end of this leaf, provided with a roller R, rides on the surface of the downstream leaf L when both are in a horizontal position. The two leaves thus form a compound lever, and the surface of the leaf L forms a movable inclined plane, with the end of leaf U rolling upon it.

The space below the gates when down and be-

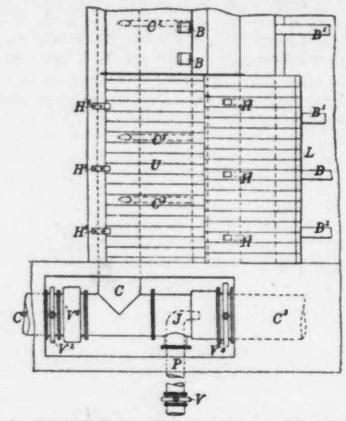


Fig. 2.—Plan of Marshall Dam, Showing Conduits and Valves with Leaves Lowered.

tween the hinges H and H^1 is called the "hydraulic" chamber; with this is connected by the smaller conduits C^1 a main conduit C, acting as a channel for the ingress or egress of water. Fig. 2 shows a cross-supply conduit C^2, C^3, connected with the main conduit C and the upper pool through the valve V^2 and the check-valve V^1, which latter prevents back pressure upstream. Valve V^3 connects the system with the lower pool. A pipe P connects with an auxiliary reservoir of water, and is fitted with a valve and a nozzle arranged to project a column of water downstream through C^3. This injector J may be arranged as a gang-jet, or be replaced by a pump; but, in any case, all the conduits must be air-tight so as to serve as suction pipes in transmitting atmospheric pressure.

In Figs. 3, B and B^1 are blocks for supporting the gates in final position, and O, O are small openings in the downstream leaf to allow the curculation of water in the small space in the hydraulic chamber behind the leaf L at the beginning of lowering, and at the end of raising this gate. A narrow leaf E, Fig. 1, prevents water under pressure from passing into this space. Diaphragms, or partitions, are shown at D, D, Fig. 3, for separating units of the dam, and these partitions also divide the hydraulic chambers into corresponding divisions. But these diaphragms are only applicable to lock gates and to situations where the dam or gate is to be raised in nearly still water. The construction is not useful in the situation shown by Fig. 1, where a head accumulates before the gate is entirely raised. A drift-cover, hinged at H^1, and riding on leaf L, is provided, to prevent gravel or other heavy drift from getting into the hydraulic chamber when the leaf L is raised. This drift-cover may be plain, perforated or a grillage, as required by the character of the drift; though it is not essential, as material can be mechanically removed from the pit.

Major Marshall shows and describes various modifications of this form of dam; especially one in which the dam may be operated in separate parts by a single supply pipe with the parts locked when raised.

In all forms of this dam or gate, however, the general operation is as follows: Water is first withdrawn from the hydraulic chamber. This causes the parts of the gates above it to be pressed into the chamber, and the dam is thus raised. To lower the gates, water is admitted into this chamber from the upper pool, thus equalizing the pressures within and without the chamber and allowing the constructional preponderance of pressure on the projecting part of the leaf L to lower this leaf to a horizontal position. In the design of this latter leaf, the preponderance given to the leaf and to the water overhang, is sufficient both to keep the leaf down and to counterbalance any sediment that is likely to accumulate above the line of the hydraulic chamber. When there is a sufficient difference in level between the mouth of the inlet and outlet conduits C^2 and C, the gates can be raised by simply closing valve V^2 and opening valve V^3. The reverse of this manipulation lowers the gates.

But as a general condition at movable dams in

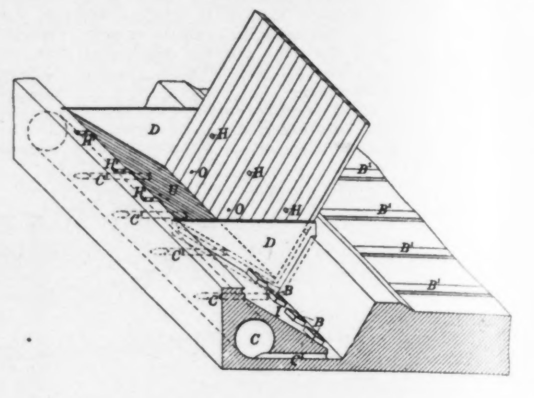


Fig 3.—Isometrical View of Marshall Dam, Showing Relative Location of Operating Pipes and Valves.

navigable rivers, this difference of level does not exist, and an auxiliary force is required to raise the dam far enough to allow a sufficient head to accumulate to complete the movement. To provide a simple means of developing this force the apparatus indicated in Fig. 4 was devised.

The operation is thus described for an imaginary dam; an elevated tank being assumed to be full of water, the gates all flat on the bottom of the river and all valves closed: In this case the dam is supposed to be 12 ft. high; the several

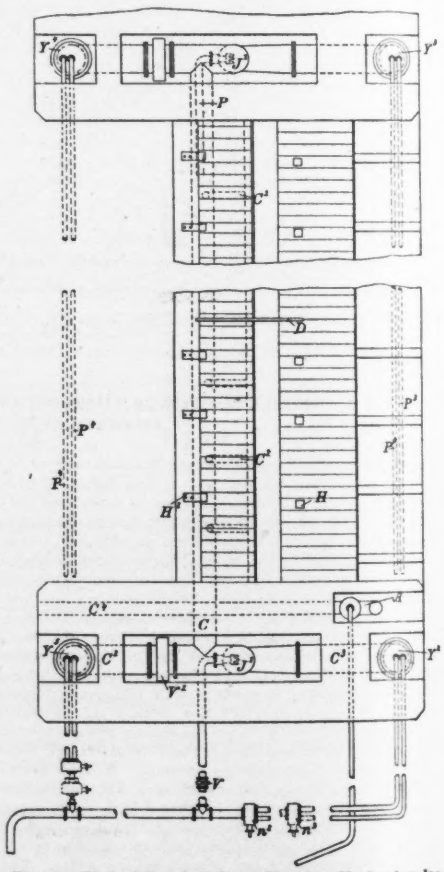


Fig. 4.—Plan of Marshall Dam, Showing Mechanism for Supplying Deficient Operating Head.

conduits C, C^2, C^3 are 4 ft. in diameter; the ejector J is made up of twelve 3-in. nozzles, or one to each square foot of pipe area, and the head furnished by the elevated tank is 36 ft., giving a jet velocity of 48 ft. per second. The dam itself is 400 ft. long, divided into three parts, or units of 133 ft. each. The outlet valve on the downstream conduit C^3 is first opened and the jet J is turned on by opening valve V. These jets forcibly eject several times their volume of water in front of them and tend to create a continual atmospheric vacuum behind them; the effect of this vacuum is instantly transmitted through the conduit C to the water in the hydraulic chamber. The underside of the gates lying over this chamber is thus relieved from back pressure, and the weight of the water and air above presses the gates into the chamber as fast as this pressure can give motion to the water in the hydraulic chamber and to the mass moved by the down-

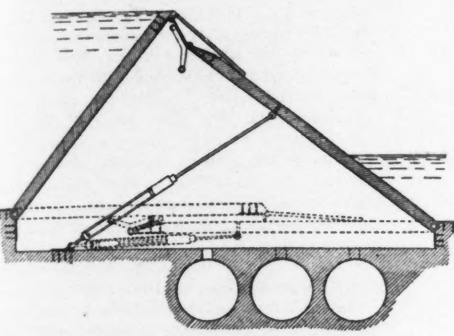


Fig. 5.—Improved Form of White Bear Trap Dam, Designed by Maj. Wm. L. Marshall.

stream leaf in rising. By the action of the jets alone the hydraulic chamber will be emptied in about two minutes, corresponding to a motion, at the crest of the dam, of a little more than 1½ ins. per second. This rate of movement can be controlled, however, by the valve V.

To lower the dam, the outlet valve Y^2 is closed and the inlet valve Y^3 and the ejector valve V are opened. The back-pressure from the jet will now shut the check-valve V^1, Fig. 2, and bring an upward pressure on the bottom of the back-leaf V, in the hydraulic chamber,, and thus release the lock. As soon as the crest of the dam moves, the ejector valve V must be closed, and the check-valve will automatically open and water will flow into the hydraulic chamber through valve Y^3 until the gate is down. By this device the capacity of the lock is doubled by reducing the time required for lockage; and as there are no projecting parts to be injured by floods, the lock may be safely submerged when it is no longer necessary for navigation. It should also be said that the inlet and outlet conduit valves are handled by pressure, supplied from the elevated tank and transmitted through the pipes shown in Fig. 4.

In another patent Major Marshall proposes to improve the original bear-trap dam of Josiah White while preserving its advantages. This improvement is shown in Figs. 5 and 6, and may be briefly described as follows: The two disconnected leaves are hinged to the foundation, as shown, and the downstream leaf has attached to its upstream end a rotating shoe, or toggle leaf. This shoe in rising travels on rollers along the under side of the upstream leaf until it strikes a stop at the top of the upstream leaf. When this shoe, with its anti-friction rollers, reaches the position shown in Fig. 6, in further rising, it rotates; the bottom leaves the under side of the upstream leaf, and the upper end pushes this leaf higher. An apron, attached to the upstream leaf, covers the shoe, excludes small bodies from the angle and gives a smooth surface for the passage of drift.

The upper and lower leaves are hinged to the foundation and the lower leaf is supported against the water pressure by adjustable telescoping tie-rods and hydraulic brakes. The tie-rod is attached to the foundation and to the lower leaf; and at the upper end of the turnbuckle, on this tie, is a cylinder fitted with a plunger, forming part of the upper rod. This chamber constitutes a water-brake, and the upward or downward movement of the dam is to some measure controlled by the rate at which water can be forced out of a continually decreasing slot in this chamber.

In Fig. 5 three operating conduits are shown, ending in rectangular chambers at each end of the dam and closed by valves at each end. In the top of these conduits are openings to the space under the leaves, each main conduit controlling one-third of the length of the dam. This dam is operated essentially as are other bear-trap dams, by admitting water under the leaves of the dam with sufficient pressure to push up the lower leaf, and thus raise the upper leaf against the pressure of the water in the upper pool. The dam is lowered by withdrawing the water from under the leaves, allowing the weight

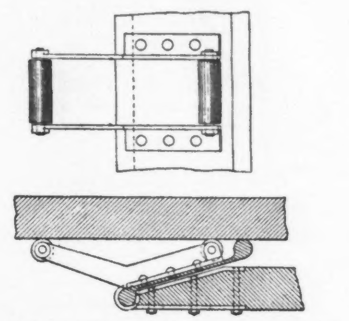


Fig. 6.—Enlarged View of Shoe or "Toggle Leaf" for Improved White Bear Trap-Dam.

of the gates, aided by the water pressure in the upper pool, to depress them.

But in the old bear-trap dams, the angle made between the two leaves, when at full height, must exceed 90° by at least "the angle of friction." This angle depends upon the material used for the leaves; if it is a case of wood on wood the angle exceeds 110°, for sliding friction, and is less for rolling friction and somewhat less for metals. This fact necessitated wide leaves and a width between the foundation hinges not less than, approximately, three times the height of the dam above its foundations. In the proposed plan the angle between the leaves may be reduced to 90°, or less; and at the same time the dam will be more sensitive and require less head of water to raise it, as there is a wider part of the upper leaf exposed to back pressure. The width of the leaves may also be materially reduced; and the width of foundation reduced to twice the height of the dam, or less, instead of three times. In rising and falling, the efficiency of the gate is dependent upon the two leaves remaining in contact at the shoe. For this reason, and to prevent undue escape of water from the hydraulic chamber, it is advantageous to make the upstream leaf materially heavier, in specific gravity, than water, and to make the downstream leaf lighter. The weights of the combination must be so adjusted, however, that the mean specific gravity of the whole gate shall be greater than that of water, so that it falls to the bottom when submerged.

CAST-STEEL RAILS or "rail junctions" are being used by Mr. C. W. Kinder, Chief Engineer of the Imperial Chinese Railway at points where the old 60-lb. rails meet the new 85-lb. rails, both of these rails being of the Sandberg section. This piece of rail is 27 ins. long, weighing 56 lbs., and is used instead of "step" splice bars to fit the different heights of the two rails. One half of the piece is made of the lighter and the other of the heavier section, and each end is joined to its respective rail by the ordinary splice bars.

STEEL RAIL PRODUCTION in 1897, says the American Iron and Steel Association's report, amounted to 1,647,892 gross tons for all kinds of rails, as against 1,122,010 tons in 1896. The output for 1897 was made up of 1,614,399 tons of Bessemer steel rails, 30,121 tons of rerolled Bessemer steel rails, 500 tons of open-hearth steel rails and 2,872 tons of iron rails. Of the total production, Pennsylvania made 1,027,996 tons, or 62%, and Illinois made over 26%. The open-hearth rails were made in Alabama and California. As to weight of rails, there were made 88,896 gross tons under 45 lbs. per yard; 1,223,435 tons, between 45 and 85 lbs.; and 355,561 tons over 85 lbs. For street and electric railway use 122,244 tons of rails were rolled. As compared with former outputs, we find the maximum production of rails of all kinds was 2,139,640 tons, in 1887; the next largest was 1,885,307, in 1890; and 1897 was the next largest year.

ACTIVE RAILWAY BUILDING IN MANITOBA is promised by the American Consul at Winnipeg for the coming season. As a result of recent legislative action, about 500 miles of railway will be built there very soon. These include the completion of the Manitoba & Southeastern, running from Winnipeg to Lake of the Woods and ultimately reaching Lake Superior; and the extension of the Lake Dauphin Road, from Sifton north to the Saskatchewan River, about 250 miles. On both these lines the Province of Manitoba guarantees principal and interest on first mortgage bonds, to the amount of $8,000 per mile, and exempts the railway properties from taxation for 30 years.

TRACK ELEVATION AND DEPRESSION at the complicated network of intersecting and connecting tracks at 16th and Clark Sts., Chicago, has been commenced, although complete plans have not yet been finally adopted. Some of the tracks will be raised above the street level, and others depressed below the level, railway as well as highway grade crossings having to be eliminated. The general plan is to build first, as far as possible, all the retaining walls necessary, and the work of putting in the foundations and building the concrete walls is now in progress. A part of the tracks of the Atchison, Topeka & Santa Fe Ry. and the Chicago & Western Indiana Ry. will then be raised to the final grade to which the tracks of the Lake Shore & Michigan Southern Ry. and Chicago, Rock Island & Pacific Ry. will be raised, crossing these two latter roads temporarily at grade while the other tracks of the first two roads are being depressed to their final grade. The plan of gradually elevating the tracks by filling in with sand has been adopted, as this arrangement will cause the least interference to the heavy traffic. It is said that the Chicago & Alton R. R. has as yet refused to accept the plans. In addition to the five roads already mentioned, two others are involved, namely, the Chicago, Madison & Northern R. R. and the St. Charles Air Line R. R. Mr. James Dun, M. Am. Soc. C. E. (Chief Engineer of the A. T. & S. F. Ry), is Supervising Engineer of the whole work, and Major G. W. Vaughn is the Engineer in Charge.

THE PINTSCH COMPRESSED GAS LIGHTING SYSTEM was in use on 83,582 cars and 3,184 locomotives on Jan. 1, 1898, according to a report just issued by the Safety Car Lighting & Heating Co., of New York. This is an increase of 6,089 cars and 166 locomotives over the same date of 1897. The division of these lights among the railway systems of the various countries of the world is shown by the following table:

	Cars.	Locomotives.
Germany	31,335	3,121
Denmark	45	....
England	16,854	....
France	5,210	....
Holland	2,890	5
Italy	1,522	....
Switzerland	335	2
Austria	3,104	....
Russia	1,536	25
Sweden	379	....
Servia	131	....
Bulgaria	27	....
Turkey	88	....
Egypt	2	....
Canada	4	....
Brazil	949	31
Argentine	984	....
Chili	46	....
India	6,356	....
Australia	976	....
United States	10,809	....
Total	83,582	3,184

It will be noticed that in both England and Germany the number of these lights in use exceeds the number in use in the United States. The increase during 1897, however, was the greatest in India, the United States and Australia. Practically all of the locomotive lights are employed in Germany, the new orders from that country during 1897 accounting for the entire increase of 166 lights installed on locomotives during that year.

THE "PIONEER" LIMITED EXPRESS recently put in service by the Chicago, Milwaukee & St. Paul Ry. between Chicago and St. Paul is made up entirely of new cars built to the company's order by the Barney & Smith Car Co., of Dayton, O. There are two trains, each composed of mail and express cars, a baggage car, buffet smoking and library car, sleeping cars, compartment cars, parlor cars, day cars, reclining chair cars, and a dining car, all of which are finished and decorated in most elaborate and luxurious style. In fact, it is difficult to see any good reason for such lavish expenditure in this direction. The baggage car has bicycle racks, and contains a Westinghouse engine and dynamo for lighting the train by electricity, while under each car is a storage battery for emergency use. The sleeping cars have 16 sections each, and are 4 ins. wider and 6 ins. higher than usual, giving increased height between the berths and increased width of gangway. Each compartment car has seven double compartments and two drawing-rooms. Wide vestibules are used. This railway is one of the few in this country which operates its own service of sleeping, parlor and dining cars, independent of the palace car companies.

RULES FOR THE REGULATION OF ACETYLENE gas hazards were approved by the National Board of Fire Underwriters at its annual meeting, held on May 19. The rules are based upon the results of an investigation made by President Henry Morton, of Stevens Institute of Technology, at the request of the National Board. They are the outcome of the attempts to introduce acetylene gas as an illuminant, and a growing demand on the part of stores for permits to keep and sell calcium carbide for bicycle lamps. Some of the requirements are as follows: Generating and gas storage apparatus must be outside of buildings, and in charge of persons properly instructed. No artificial light or any heat other than steam or hot water will be allowed in the generating or storage room. Bicycle and other portable lamps are not approved in their present form. The storage of liquid acetylene or the use of gas made from liquid acetylene is absolutely prohibited. In the construction of generating and storage apparatus nothing but wrought iron or steel is allowable as the gas may form an explosive compound with copper and its alloys. The generator in every case must be constructed so that charging or the removal of residue can be effected without the escape of gas or the admission of air.

ELECTRICAL SUBWAYS IN PROVIDENCE, R. I., are to be provided if plans now well under way are carried out. In accordance with a report and recommendation of a joint special committee of the city council an ordinance has passed one branch of that body providing for the removal of all the overhead wires, within certain districts of the Narragansett Eclectric Lighting Co. The same branch of the council has also adopted a resolution authorizing the committee to proceed with plans for the removal of remaining wires. The lighting company has three years in which to build subways, but must remove one-third of its wires each year. The company, apparently in return for an extension of its contract, not only waives its contract right for an increase in the price of street lighting whenever it buries its wires, but agrees to reduce the price of 2,000-c. p. arc lamps from 35 to 32½ cts. per night for three years after June 15, 1900, and to 30 cts. for the next three years. Besides this, all new arc lamps from the date of the proposed contract will be furnished for 30 cts. each and new 32-c. p. incandescent street lamps for $24 per year; the old incandescent lamps are to be kept lighted at a discount of 65%, in place of 50%, from the original contract price. It is estimated that the company will place ducts in about 16 miles of streets. Mr. Henry B. Winship is chairman of the committee having this matter in charge, and Mr. M. J. Perry is vice-president and general manager of the Narragansett Electric Lighting Co.

THE GARBAGE DISPOSAL CONTRACT AT BUFFALO, N. Y., recently awarded to Grattan & Jennings for a term of five years at a total sum of $79,200, has been assigned, according to reports, to the Baynes Reduction Co. The latter company has disposed of the garbage of the city for about ten years, employing the Merz system of reduction. It is, therefore, in shape to continue the present system of disposal. As the present contractors have been receiving $35,000 a year for their work and bid $45,000 a year, or $220,000, for the new contract, it is possible that the above report and the prices given are incorrect, but we give them as stated in the Buffalo papers. The Merz system, as used at Buffalo, Detroit, Milwaukee and St. Louis, was described at length in our issue of Nov. 1, 1894.

ALUMINUM PLATED WITH COPPER, in sheets and in wire, is described by Mr. L. Sattler in the "Annalen fur Gewerbe und Bauwesen." He there refers to a process for drawing, or plating, the aluminum while hot under a thin covering of copper, and claims that sheets and wires can thus be made which possess all the qualities of aluminum, but can be soldered and otherwise treated like copper.

SEMI-STEEL, SO CALLED, is discussed by Mr. A. E. Outerbridge, Jr., in the April number of the "Digest of Physical Tests." It is made by melting some steel scrap together with cast-iron. The result is a cast-iron with some of its qualities, as softness and strength, modified, and it is in no sense a steel or "semi-steel." As Mr. Outerbridge says:

The simple fact is that the melting of steel with pig iron causes the steel to lose its identity completely, but the pig iron does not thus lose its characteristic qualities, and the resulting material is simply a strong, close-grain cast-iron which has neither chemical nor physical relation or resemblance to steel.

THE CHARGES FOR ELECTRIC CURRENT by the Cataract Power & Conduit Co., of Buffalo, furnished from Niagara Falls, were given erroneously in our issue of April 28. The correct statement is as follows:

All payments for power are to be made monthly and the amount of each monthly payment will consist of a charge for service, and, in addition thereto, a charge for power. The charge for service is $1 per kilowatt per month, and this charge will depend only upon the amount of power which the user may require the Cataract Power & Conduit Company to keep available and ready for his use. The monthly charge for power will depend upon the aggregate

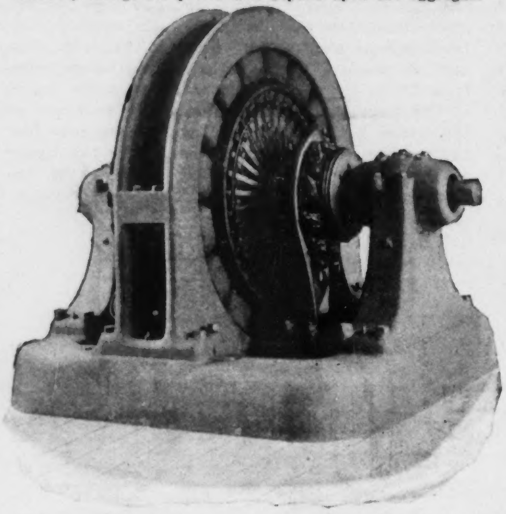


Fig. 1.- Rotary Converter; 400 K-W., 16 Poles, 450 Revolutions per minute; Transforming Two-Phase Current to Direct.

General Electric Co., Schenectady, N. Y., Makers.

amount used, as determined by integrating meters installed by the Conduit Company upon the premises of the consumer. The charge for power will be determined from the following schedule:

Units (K-W. hrs.) used per month.	Charge per unit — For current up to		For the excess.
Up to 1,000	1,000 units,	2.0 cts.	... cts.
1,000 to 2,000	1,000 "	2.0 "	1.5 "
2,000 " 3,000	2,000 "	1.5 "	1.2 "
3,000 " 5,000	3,000 "	1.2 "	1.0 "
5,000 " 10,000	5,000 "	1.0 "	0.8 "
10,000 " 20,000	10,000 "	0.8 "	0.75 "
20,000 " 40,000	20,000 "	0.75 "	0.70 "
40,000 " 80,000	40,000 "	0.70 "	0.66 "
Over 80,000	80,000 "	0.66 "	0.64 "

As power other than electric is usually measured in horse-power, it may be useful to have the above figures translated into their equivalent horse-power units, as below:

1 K-W. hr. = 1.34 HP. hrs. 1 HP. hr. = 0.746 K-W. hr.
$1 per K-W. per month = $8.95 per HP. per year.
1 HP. for 1 year of 300 working days (10 hrs. each) = 3,000 HP. hrs = 2,238-K-W. hrs.
1 HP. for 1 year of 365 days (24 hrs. each) = 8,760 HP. hrs. = 6,535-K-W. hrs.

	The charge for 1 HP. will be per year of — 300 days, 10 hrs. each.	365 days, 25 hrs each.
At the rate per K-W. hour of 0.64 cts.	$14.22	$41.82
.66 "	14.66	43.13
.70 "	15.67	45.75
.75 "	16.78	49.01
.80 "	17.90	52.28
1.00 "	22.38	65.35
1.2 "	26.86	78.52
1.5 "	33.57	98.03
2.0 "	44.76	131.70

The above figures do not include the charge "for service" of $1 per K-W. month = 8.95 per HP. per year.

The following table shows the relation between kilowatts per month and horse-power:

Kilo-watts, per month.	HP. hours, per month.	Horse-power for 250 hrs. in a month.	Horse-power for 730 hrs., in a month.
1,000	1,340	5.36	1.84
2,000	2,680	10.72	3.67
3,000	4,020	16.08	5.51
5,000	6,700	26.80	9.18
10,000	13,400	53.60	18.36
20,000	26,800	117.20	36.72
40,000	53,600	234.40	73.43
80,000	107,200	468.80	143.83

THE INTERNATIONAL MINING CONGRESS, organized at Denver, in July, 1897, is to hold its first session in Salt Lake City, Utah, on July 6, 7, 8 and 9, 1898. The objects of the congress are to secure such national legislation as will promote the business interests and develop the mining industry in North and South America; bring mining men and investors together; to cultivate proper relations between mining, commercial and labor bodies represented, and especially to take under advisement the creation by Congress of a Department of Mines and Mining in the national government. As a result of the Denver meeting, Congress has already been petitioned under the above heads, the Federal mining laws are being recodified and rearranged, and a wider interest in mining has been promoted. At the coming congress a large representation is expected, and governors of states and territories, foreign countries, mayors of cities and all mining, commercial and labor organizations have been invited to send delegates. The chairman of the local executive committee is Hon. Heber M. Wells, Governor of Utah, and the secretary is Mr. W. D. Johnson, Salt Lake City, Utah, to whom all communications should be addressed.

A LARGE ROTARY CONVERTER AND ITS REGULATING TRANSFORMERS.

What is claimed to be the largest 60-cycle rotary converter yet constructed was recently installed in the station of the Pennsylvania Heat, Light & Power Co. of Philadelphia, Pa. In the nomenclature of the General Electric Co., at whose works it was built, the machine is known as a QC 16—400—450, which means that it has 16 poles and has an output of 400 K-W. when running at 450 revolutions per minute. There are two sides to the converter, the direct and the alternating, the latter being the side shown in Fig. 1. Two-phase alternating current of a frequency of 60 cycles and a voltage that can be varied from 165 to 220, is supplied to the ironclad armature by a system of collector rings and flexible brushes. At the other end of the armature a commutator mounted upon a separate spider, to facilitate renewals or repairs, delivers the direct current at from 225 to 300 volts, according to requirements. To insure cool running and to prevent cutting, the commutator surface is large, and a back and forth movement is given to the armature by a magnetic device placed in the bearing at one end of the shaft.

Several features have been introduced in connection with the brush holders, studs and means of attaching them to the yoke, which greatly facilitate the removal of the brushes for examination or replacement. Another excellent feature is the provision for sliding the field frame to one side so the field coils or armature can be examined, cleaned or repaired, the latter, however, being a somewhat remote contingency. The machine stands 8 ft. high and has a base 8 ft. 4 ins. × 8 ft. 6 ins.

Variation of the direct current is accomplished by changing the voltage of the two-phase side. This is done by cutting in or out turns of the primary winding of the two regulating trans-

Fig. 2.- Regulating Transformer; 200 K W., 60 Cycles, Primary Voltage 2000, Secondary from 165 to 220 Volts.

General Electric Co., Schenectady, N. Y. Makers.

formers, Fig. 2, by means of the dial switch placed on the front of each transformer casing. These regulating transformers are of 220 K-W. capacity each, are wound for a primary voltage of 2,000 and a secondary varying from 165 to 220 volts.