ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

VOL. XL. No. 1.

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THE PLANS FOR THE FOUR NEW MONITORS, authorized in the last naval appropriation bill, call for the following general dimensions: Length on normal load water line, 225 ft.; extreme beam at water line, 50 ft.; mean draft at normal displacement, 12½ ft.; normal displacement, about 2,700 tons; total coal capacity, loose stowage, 200 tons. They are to be harbor-defense vessels and are to cost not more than $1,250,000, exclusive of armament. They must be built within 27 months from time of contract. The hull will be of steel, unsheathed, with double bottom and water-tight divisions; there will be one military mast. The side armor belt will be 11 ins. thick and taper to 5 ins. at the ends; it will be 5 ft. deep. The barbettes for the 12-in. guns will be 11 ins. thick; the protective deck will be 1½ ins. thick and the conning tower 7½ ins. thick. There will be two vertical triple-expansion engines, operating twin screws, and four water-tube boilers working up to 250 lbs. steam pressure. Two 12-in. guns will be mounted in a barbetted turret amidships forward, with four 4-in. rapid-fire guns in broadside on the superstructure deck, and a secondary battery of seven rapid-fire guns. The ship must develop a speed of 12 knots for two consecutive hours, with a penalty of $5,000 per quarter knot below that to 11 knots; if the speed is below 11 knots the vessel will be rejected.

THE CLIMATE OF CUBA AND MANILA is made the subject of a special report by W. F. R. Philips, of the U. S. Weather Bureau. In both cases the sources of information are very meager; those of Cuba being practically confined to Havana. At this place the highest temperature recorded in ten years is 100.6° F., while it has been 104° F. at Washington, D. C., in that period. The mean annual temperature at Havana, for the years 1888-97, is about 77° F. July is the warmest month, with an average of 82.4° F.; in January the average is 70.3° F. At Santiago de Cuba, the only data available would indicate a mean temperature of 80° F., with a range of only 6° between the hottest and coldest months. The average diurnal range in temperature about Havana is about 10°. The average Havana rainfall is about 52 ins. per year, and the rainy season occurs between May and October, with the greatest rainfall in October and the next greatest in June. The relative humidity averages about 75% of saturation and is practically constant for the year; the absolute humidity is very great; the Havana average is about 7.5 grains of vapor to one cubic foot of air. This varies from 6.2 grains in January to 8.9 grains in September. On the average rain falls in one day out of three at Havana, with heavy down pours of short duration as the characteristic. The heaviest daily rainfall recorded is 6.27 ins. in May and 5.32 ins. in October. The average wind velocity at Havana, from the "Northeast Trades," is 7.5 miles per hour, varying from 8.5 to 6.5 miles. The heaviest tropical storms occur in August, September and October.

Manila, the capital of the Philippine Islands, is situated in latitude 14° 35′ North and in longitude 121° East of Greenwich. Observations have been made for many years at the Observatorio Meteorologico de Manila, and rainfall and other notes have been published for 17 years. From these we find the average temperature for the year to be 80° F., with April, May and June as the hottest months. December and January are the coolest, with an average of 77° F. The highest reading of the thermometer is 100° and the lowest recorded is 74°. The average relative humidity is 78%, with 85% in September and 70% in April. The average absolute humidity is 8.75 grains in a cubic foot. The average annual rainfall is 75.43 ins., of which more than 57% falls in July, August and September. The last is the most rainy month of the year, the rainfall averaging 15.01 ins.; and February is the dryest month, with 0.47 ins. The annual rainfall is marked by irregularity; as much as 120.98 ins. have fallen in one year; and only 35.65 ins. in another. In one September the rainfall was 61.43 ins., and in another September only 2 ins.

THE HIGHEST METEOROLOGICAL STATION IN the world is on top of El Misti, with an elevation of 19,200 ft. above sea level; it is on an extinct volcano near the town of Arequipa, Peru. This station is one of a series of eight operated in connection with Harvard University near Arequipa, with the lowest only 55 ft. above sea level, and two others of 13,400 and 15,700 ft. elevation respectively. These establishments are the result of a bequest to Harvard, left by Mr. Uriah A. Boyden in 1887. The purpose of the bequest was to establish an observatory at such an elevation as to be as free as possible from the atmospheric influences effecting other stations. The highest station on El Misti is 3,500 ft. higher than the one on Mont Blanc. The instruments used include dry and wet bulb minimum and maximum thermometers, rain-gage, Richard baragraph, thermograph and hydrograph, also a meteorograph, designed to run for three months and record temperature, pressure, humidity and wind direction and velocity. These stations are regularly visited about once in a month, to wind up the clocks and change the record-sheets. Though the road is easy enough the trip to the top of El Misti is an exceedingly exhausting one to the uninitiated.

THE ANNUAL RAINFALL AT RIVAS, near the Pacific coast of Nicaragua, says Dr. Earl Flint, of that town, was 123.43 ins. in 1897, or the greatest during the 18 years of his observations. Rivas is about 4 miles to the west of Lake Nicaragua and nearly on the line of the proposed Nicaragua Canal. Previous records by Dr. Flint, as reported by the engineers of the Nicaragua Canal Co., ranged from 30 to 90 ins. for the year. On the Atlantic side of Nicaragua, at Greytown, the annual rainfall in 1890 was 320.48 ins., with 274.85 ins. in the Deseado Valley, 12 miles inland.

THE PHILIPPINE ISLANDS, as described by U. S. Consul O. F. Williams, of Manila, cover 150,000 sq. miles and have a population of 8,000,000 to 10,000,000. The Island of Luzon, on which Manila is situated, is larger than the States of New York and Massachusetts and has 5,000,000 population; the Island of Mindanao is nearly, if not quite, as large. In all, there about 2,000 islands in a land and sea area of 1,200 miles in latitude and 2,400 miles in longitude. Of the hemp exports of 1897, 914,055 tons, 41% went to the United States; more than 55% of the 1,582,904 tons of sugar, exported in the same year, came to this country. The average annual value of hemp and sugar exports to the United States, for the last ten years, was $8,926,372. There is but one railway in the islands, the 123 miles from Manila to Dagupin. This is a well built, single track line, with steel rails, stone or iron bridges and English locomotives making 45 miles per hour. The government assisted in the building of this railway by granting valuable land concessions and guaranteeing 8% on the stock for 99 years. The road pays more than 10% per annum. There are about 25,000 Europeans in the islands, of which 12,000 are at Manila. Trade is in the hands of English, Spanish and German houses.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred June 28 at Vine Grove, on the Illinois Central R. R., about 37 miles from Louisville, Ky., and resulted in the death of two persons, the engine driver and fireman. The train was a coal special bound for Louisville, and was running at a good rate of speed, when, owing, it is stated, to the spreading of the rails, the locomotive and twelve cars left the track. The damage is estimated at $6,000.——A passenger train deraliment on the Wabash R. R., near Burlington Junction, Mo., on June 29, resulted in the injury of some 20 persons, several of them seriously.——The explosion of a locomotive boiler on a suburban branch of the Erie R. R., at Essex Falls, N. J., on July 4, resulted in the injury of the engine crew. The cause of the explosion is not yet known.

THE FAILURE OF A HIGHWAY BRIDGE crossing the Mohican River at Shelby, O., on July 4, precipitated about 1,000 people into the river 13 ft. below. Four persons were killed and nearly 100 injured. A public wedding was being celebrated on the bridge at the time of the accident.

A TORNADO-LIKE STORM which occurred along the North Atlantic coast on July 4 resulted in a large amount of damage to property and the death of a number of people. At Hampton, N. H., four persons were killed by the destruction of a crowded skating rink and five were drowned by the capsizing of a yacht sailing off the beach. The foundering of the excursion steamer "Surf City" in the harbor at Beverly, Mass., resulted in the death of eight persons. Less serious accidents occurred to pleasure craft and sea shore resorts at other points on the New England coast.

THE SINKING OF THE STEAMSHIP "LA BOURGOGNE" with the loss of 553 lives is reported in dispatches from Halifax, N. S., as we go to press. According to the latest reports, the "La Bourgogne" when about 60 miles south of Sable Island on her regular trip east, collided with the British steamer "Cromartyshire," at about 5 o'clock a. m., on July 4, and sunk within a few minutes after the collision. There were on board of the French liner at the time of the collision 75 first cabin, 123 second cabin and 285 steerage passengers, and a crew of 233 men, in all 716 persons. Of this number, 53 passengers and 110 of the crew escaped in boats and were picked up by the "Cromartyshire," which was herself badly damaged, and had to be towed into Halifax by the steamer "Grecian" of the Allan Line. According to the statement of the captain of the "Cromartyshire" the collision took place in a fog, and the French steamer was running at a high rate of speed when his ship struck the liner amidships, tearing a great rent in her plates. When the fog lifted, one-half hour later, the "La Bourgogne" had disappeared, having sunk, and only two boats and some life rafts, crowded with passengers from the ill-fated vessel, were visible. The sunken steamer was 7,400 tons gross tonnage, and was the third largest ship of the fine fleet of the Compagnie Generale Transatlantique. She was 508 ft. long, 52 ft. beam, and 38 ft. deep, and had engines of 9,000 I. HP. This was the third collision which the ship had had. On Jan. 4, 1890, she collided with the British steamer "Torridon" near the Scilly Islands, carrying away the stern of the British vessel and suffering slight injuries herself, and in February, 1896, she ran into and sunk the steamship "Ailsa," during a fog in the lower bay of New York harbor. There was no loss of life in these two earlier accidents. The "Cromartyshire," which suffered in this last collision, was a three-masted iron freight steamer of 1,554 tons gross tonnage, 249 ft. long and 32.8 ft. beam. All of the officers of the "La Bourgogne" were among the drowned, except the purser and three engineers.

THE "WHALEBACK" STEAMER "Alexander McDougall," launched at Superior, Wis., on June 25, was designed by Mr. Albert C. Diericx, of the American Steel Barge Co. She is 430 ft. long over all, 414 ft. keel, 50 ft. beam and 27 ft. molded depth. There is a 5-ft. double bottom, with a water-ballast capacity of 2,000 tons and her displacement is nearly 10,000 tons, with a cargo capacity of 7,200 tons. She has quadruple expansion engines. The vessel has 13 hatches for loading, each 24 × 8 ft. in the clear and 24 ft. apart on centers; her coal capacity is 350 tons and she is fitted with two 90-ft. masts.

BUILDINGS AT THE OMAHA EXHIBITION.

In our issue of May 19 we briefly described the scope and purpose of the Trans-Mississippi & International Exhibition, now being held at Omaha, Neb., and also gave some particulars of the principal buildings. We now present views of four of the buildings, and from these and the particulars already given it will be evident that the exhibition has been planned upon the artistic basis so perfectly carried out in the design of the ever-memorable Columbian Exhibition at Chicago in 1893.

The U. S. Government Building, Fig. 1, is at the head of the "grand canal," and consists of a central portion and two wings. The former is 208 ft. long, 150 ft. deep and 58 ft. high to the top of the parapet above the cornice. The dome is surmounted by a figure of "Liberty," whose torch is 178 ft. above the ground. The wings are each 148 × 100 ft., and 44 ft. high. They are connected by colonnades with the Fine Arts Building and the Agricultural Building. The total frontage is 504 ft., and the floor space devoted to exhibits aggregates 50,000 sq. ft. This building was designed by the Supervising Architect of the U. S. Treasury Department.

The Manufactures Building, Fig. 2, is 400 ft. long and 40 ft. high to the main cornice. The main entrance, 24 ft. wide and 34 ft. high, is in a center pavilion 64 ft. long, and at each corner of the building is a pavilion 40 × 40 ft. The height to the top of the group of statuary over the main pavilion is 85 ft., while the height to the tops of the flat domes of the corner pavilions is 65 ft. The windows are 10 ft. wide and 24 ft. high, placed 16 ft. apart. The architect was John J. Humphrey, of Denver, Colo.

The Mining Building, Fig. 3, is treated in a somewhat more ornate style, and has a circular portico or main entrance 50 ft. in diameter, surmounted by a dome formed as a series of circular steps. The top of the dome is 75 ft. above the ground. This portico projects beyond the face of the building, and is flanked by open colonnades extending to the towers at the corners. The building was designed by S. S. Beman, of Chicago.

The Horticultural Building, Fig. 4, is 310 ft. × 130 ft., with a height of 160 ft. to the top of the central tower, or belfry, in which will be placed a set of chimes. The central portion of the building is octagonal in plan, formed by square towers with connecting curtain walls, and above this is a glass dome surmounted by a gallery accessible to the public. The main entrance is a Greek portico, and domed pavilions mark the corners of the building. The architect of the building was Charles F. Beindorf, of Omaha, Neb.

The exhibition was opened on June 1 by President McKinley at Washington, who pressed an electric button, starting the machinery and unfolding a flag on the Government Building. It will remain open until November.

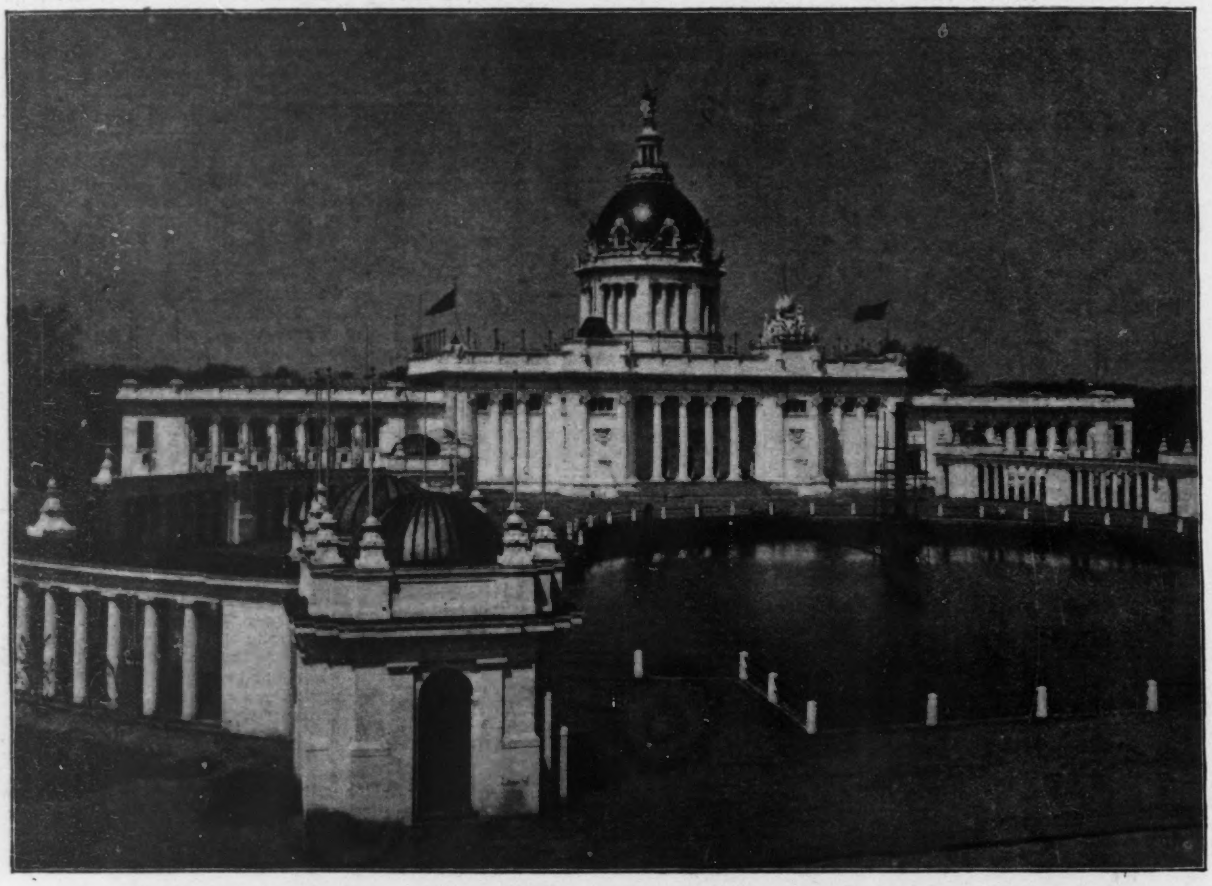

FIG. 1.—UNITED STATES GOVERNMENT BUILDING. TRANS-MISSISSIPPI AND INTERNATIONAL EXHIBITION.

THE NEW U. S. GOVERNMENT NEEDLE DAM AT LOUISA, KY., ON THE BIG SANDY RIVER.

(With double-page plate.)

General Features.

The new Poiree needle dam, which was opened for public use on Jan. 1, 1897, at Louisa, Ky., on the Big Sandy River, is a radical departure in many particulars from the dams of this type heretofore built in France and Belgium, where the Poiree system originated and has been most extensively used. First among its notable features probably is that it sustains a head of water which considerably exceeds that supported by any other dam of the trestle or wicket type yet constructed. Besides this, however, the construction and operation of the trestles, needles and raising and lowering machinery also embody new features never employed before, and finally it is stated that the cost of the dam was relatively smaller than that of previous Poiree dams, so far as is known. These facts alone are sufficient to make the new dam worthy of notice, but as we point out elsewhere in this issue, it also deserves attention as a representative example of the very high class of structures which the latest improvements of our inland rivers for navigation is calling upon engineers to design.

Through Mr. B. F. Thomas, M. Am. Soc. C. E., U. S. Assistant Engineer, who designed and constructed this dam, we have, therefore, secured a number of photographs of the completed work, which we supplement with the accompanying description and line drawings abstracted from the official report of the same officer published in the "Report of the Chief of Engineers" for 1897.

Conditions Governing Type of Dam.—The new dam is located near Louisa, Ky., just below the junction of the Levisa and Tug rivers, which unite to form the Big Sandy River, which in turn empties into the Ohio River about 26 miles north of the junction. The Levisa River is navigable by steamboats during a good part of the year for a distance of 100 miles, and the Tug River for a distance of 60 miles. Beyond these points pushboat navigation is possible throughout the year, except in periods of extreme low water, which are usually of short duration. Both streams carry a large amount of sand and debris, which would be very likely to form bars and snags in a permanent pool, such, for example, as would be caused by a fixed dam.

A more important reason why a movable dam seemed desirable was the nature of the commerce, which is very largely timber in rafts. There are times when rafting stages of the river are infrequent, and hundreds of rafts are awaiting sufficient water to reach the Ohio River. When the long-delayed rise comes, it is often of short duration and has to be taken advantage of at once. In such cases the delay necessary to pass the commerce through the lock of a fixed dam would very likely result in a failure to reach the markets along the Ohio and Mississippi rivers during an entire season. The same argument applied to the shipment of coal in barges, which seems likely to become a quite important portion of the traffic as soon as the neighboring coal fields are developed. There were various other reasons why a movable dam seemed preferable to a fixed dam, which was the type of structure originally contemplated, but they need not be detailed here.

Choice of System of Movable Dam.—A movable dam having been decided upon, the next step was to choose a system best adapted to the conditions. These conditions were briefly as follows: (1) An unprecedented head of water to be sustained; (2) sudden and unexpected rises in the stream; (3)

the great amount of sediment and drift carried; (4) the great difference in level between high and low water, and (5) the small low water discharge. The high lift was unfavorable to the use of needles; the sudden freshets were an argument against any form requiring much time for maneuvers; the drift and sediment, to any system having trestles; the height of high water and the high banks, to bridge dams; and the small discharge of the river, to wickets of the Chanoine type. The Chanoine wicket and the Poiree needle seemed upon study, however, to have the fewest disadvantages, and it was finally decided to build a needle dam, with a supplementary lock. The works as finally constructed (Fig. 1), therefore, consisted of (1) a lock on the right, or Virginia bank, 52 ft. wide and 255 ft. long over all; (2) a navigation pass next the lock 130 ft. long, having a depth of 13 ft. of water on its sill, and (3)) a weir 130 ft. long separated from the pass by a masonry pier 12 ft. wide and terminating in an abutment 17½ ft. wide on the left, or Kentucky bank. The weir has a depth of 7 ft. of water on its sill.

Lock.

The lock, which is of sandstone masonry, is 255 ft. in length, with a distance between quoins of 190 ft. and a clear width of 52 ft. The walls stand 21 ft. above the lower miter sill level. The lower miter sill is at an elevation of 9 ins. below the low water mark of 1883, and the upper miter sill is 2 ft. above the lower. The gates are of wood, and are of the miter pattern. The filling of the lock takes place through valves in the upper gates and the discharge through culverts in the side walls, which connect the lock chamber with the pool below. In constructing the lock the entire site was enclosed by a coffer-dam, inside of which the excavation and masonry work were carried on by ordinary well-known methods. The cost of the lock, including everything properly chargeable, was $120,372. The object of the lock is, of course, to pass the traffic during stages of low water when the dam is raised.

Construction of Movable Dam.

As already stated, the movable dam proper is divided by a pier into two parts, the navigation pass and the weir. The purpose of the pass, as its name indicates, is to accommodate the navigation during high water, while that of the weir is to pass the surplus water. In deciding upon the dimensions to be adopted, the pass, of course, had to present an opening long enough to be run safely by the rafts, tows, etc., of the kind that navigate the Big Sandy River, and deep enough so that its sill should not form an additional obstruction; that is, it had to be below the highest natural obstructions in the river. To satisfy the first condition it was thought that an opening of 130 ft. would be ample, while the depth would be sufficient if the sill were placed 1 ft. below the low water level of recent years. The conditions to be satisfied in dimensioning the weir were: (1) The area of discharge must be sufficient, when taken in connection with those of the pass and lock to permit the passage of discharges corresponding to all stages up to the level of the top of the pier and abutment, without causing a greater swell head than 0.5 ft.; (2) the discharge area of the weir should be sufficient to pass all discharges corresponding to stages up to that at which the natural river is navigable, without the removal of any needles from the pass. It was found that these conditions would be satisfied by placing the sill of the weir 6 ft. above that of the pass and making it 140 ft. long.

Substructure.—The dam is founded on sandstone, varying in depth below low water from 3 ft. at the lock wall to 24 ft. at the abutment. Upon this, after removing the overlying sand and gravel and the softer top parts of the ledge proper, was built the substructure of concrete and sandstone masonry. Figs. 2 and 3, transverse sections through the pass and weir respectively, show the construction of this substructure quite clearly. In the pass it is 22 ft. wide at the coping and in the weir 17 ft. wide, while the heights are, respectively, 12 ft. and 24 ft.

Trestles.—The pass is closed by 31 and the weir by 34 steel trestles, spaced 4 ft. apart c. to c., which terminate in eyes at the bottom and are connected to journal boxes by pins. The pass trestles, Fig. 4, are 15 ft. 2 ins. high, and weigh 1,140 lbs. each, and the weir trestles are 9 ft. 8 ins. high and weigh 920 lbs., and they have bases 9 ft. 10½ ins. and 6 ft. 5 ins. long, respectively. The other features of the trestle construction are shown by the drawings, Figs. 2, 3 and 4.

The trestles are rigidly connected by two independent constructions, and the maneuvering chain constitutes still a third connection. One of these connections is the bar which forms the upper support of the needles. This bar is hinged vertically to each trestle at the pool level so as to swing horizontally, and has its opposite end formed into a hook on its upstream side, which engages with a lip or projection on the next trestle. It is held in position by a crank-shaped rod which may be turned from the walkway by a wrench when it is desired to let the bar swing free. When in use the crank-shaped rod is held from turning by a latch, which is disconnected when the wrench is dropped over the head of the rod. The second means of connecting the trestles is the sheet-iron floor plates. Each floor plate is hinged to its trestle horizontally and spans the opening to the next trestle, to which it connects by means of hooks at two points. A latch moved by the foot holds each section in position.

In a frame bolted into the head of each trestle is a combined ratchet and chain wheel, over which a chain passes from one end of the pass to the other. There is also a similar chain for the weir. One end of each chain is fastened, in the case of the pass to the trestle nearest the pier, and, in the case of the weir, to the trestle nearest the abutment. The other ends of these chains are wound on chain crabs, located respectively on the lock wall and the pier. By means of a pawl dropping into the ratchet, the rolling of the chain wheel may be stopped, and when this occurs the trestle is attached to the chain and the winding of the crab will move it as desired. Fig. 5 shows the construction just described quite clearly, and a little further on its operation in raising and lowering the trestles will be described.

Needles.—The needles are of white pine and are 12 ins. in width. The pass needles are 14 ft. 3 ins. long, 8 ins. thick at the bottom, 4 ins. thick at the top, and weigh when wet 263 lbs. each, and the

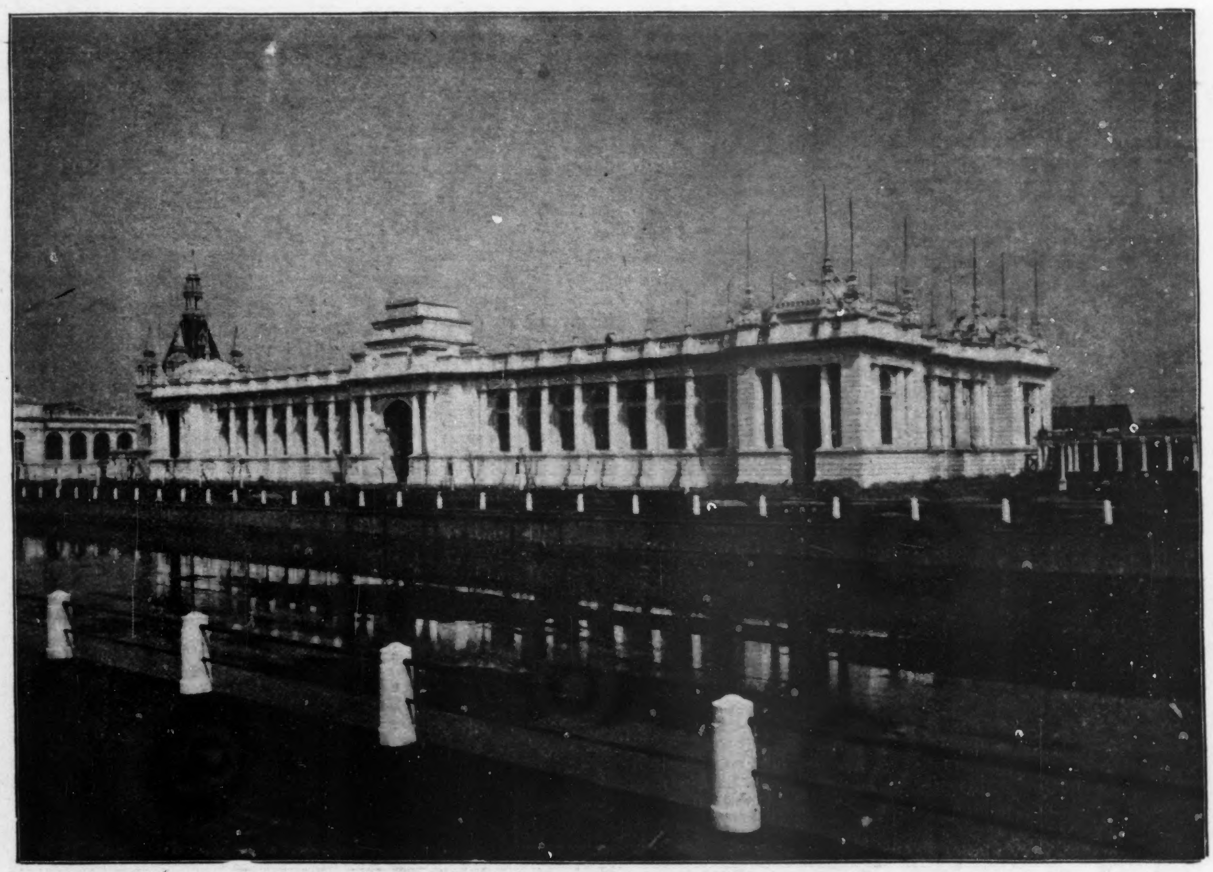

FIG. 2.—MANUFACTURES BUILDING. TRANS-MISSISSIPPI AND INTERNATIONAL EXHIBITION.

weir needles are 8 ft. 3 ins. long, 3½ ins. thick at the bottom, 2½ ins. at the top, and weigh about 80 lbs. All needles are banded at the top and bottom, the bands being countersunk, and carry iron handles and suitable attachments for connecting the chains to place and remove them. In the sides of the pass needles a shallow groove is cut which will hold a strip of rubber should it become desirable to restrict the leakage. The pass needles when not in use are stowed on a boat built for the purpose. This boat is provided with two overhead tracks on which run trolleys for lifting the needles from the piles and carrying them to the end of the boat when they are to be put in the dam and for piling them when they are to be stored.

Drift Boom.—The river, as already stated, carries a large quantity of drift which, if it were not deflected, would interfere with the operation of the dam and might even injure it seriously. To deflect this drift the drift boom has been provided. This boom consists of four parallel timbers rigidly bolted together and having rudders at intervals of 30 ft., and reaches from a point some distance above and on the opposite bank from the lock to the crib at the river wall of the lock, thus guiding all drift into the lock through which it is passed. The rudders on the boom are controlled by a wire wound on a capstan at the end, and by setting them at the proper angle the boom can be held out in the stream at any point required.

Operation of Movable Dam.

From the description and illustrations just given the construction of the several parts of the Big Sandy River needle dam will be pretty clearly understood. A brief explanation will be sufficient to make its operation equally clear.

Raising the Trestles.—The raising of the trestles may be accomplished in two ways: (1) By a crab located as already stated, on the pier, for the pass trestles, and on the lock wall, for the weir trestles; (2) by the needle boat anchored above and raising the chain passed over a sheave and leading to the drum of the boat engine. Up to the present time the latter method has been but little employed owing to the lack of a suitable engine on the needle boat.

By the first method the chain is wound in by the crab and is stowed away in a suitable recess in the masonry. As the chain is wound in it brings up the first trestle and starts others. When the first trestle is nearly upright the attendant, standing on the masonry lifts the end of the floor section a few inches which depresses one end of the pawl and raises the opposite end out of the ratchet in the chain wheel, as shown by Fig. 5. This severs the former rigid connection between the trestle and the chain, and the attendant can handle the trestle at will without the crabman stopping the winding in of the chain. He, therefore, hooks the floor section into place and fastens it with the foot latch, and then, standing on the bridge thus formed, swings the connecting bar into place and locks it by a turn of the crank bar. By this time the floor of the second trestle comes within easy reach, and the attendant proceeds to lock this trestle just as he previously did with the first. A repetition of this process raises the entire number of trestles, the work for either the pass or the weir consuming about 40 minutes.

It will be observed that, by winding in the length of chain at which the trestles are spaced, each trestle is brought up. After the first one, which has a sufficient length of chain to reach from the top to the bottom of the masonry, and thence to the head of the trestle when down, the length is generally 4 ft.; that is, the trestles themselves are 4 ft. between centers, and, by allowing 8 ft. of chain to each it is only necessary to wind in 4 ft. of this to bring the trestles properly into position. When the last trestle has been raised, a rolling bridge is drawn out from a recess in the masonry and connected with it, and thus a foot bridge is completed from one part of the masonry to the other.

Lowering the Trestles.—In lowering the trestles the attendant stands on the foot bridge and first unhooks the rolling bridge and pushes it back into its recess. He then disconnects the escape bar of the last trestle and throws it around against its trestle and then unhooks the floor section, which falls upon the chain and rests there. The crabman then slacks the chain, allowing the trestle to fall. When the chain has been run out about 4 ft. the attendant throws the pawl of the standing trestle into its ratchet and thus the descending restle is stopped. The escape bar and floor section of this trestle are then relieved and it begins to fall as the chain is paid out, until when the chain has run out about 4 ft. the operation of throwing the pawl into the ratchet of the next standing trestle is repeated. A repetition of these maneuvers brings all the trestles to their beds with their floor sections resting on top of them. The time required for lowering either pass or weir is about 40 minutes.

Placing the Needles.—Two methods have been employed for placing the needles in the dam.

(1) The pass needles, as previously stated, are stored on a special boat (Fig. 6), which is anchored so that its bow is only a few feet upstream from the trestles, with their heads or tops all in one direction toward the dam. A trolley track runs over the pile of needles on each side of the boat, and the trolleys have sheaves over which pass chains having hooks at their free ends. At about the center of weight of each needle is a ring. By placing the chain hook in this ring and pulling down on the free end of the chain the needle is raised from the pile. Near the hook is a catch or claw on the chain, the purpose of which is to hold the bight of that part of the chain pulled down in raising the needle. Thus the needle, after being raised, remains suspended, and by pushing it the trolley rolls along the track overhead and carries it out to the bow of the boat. When the needle is brought to the end of the trolley track its head projects over the foot bridge, where it is grasped by the attendant and placed on the support bar alongside the last needle put in. The trolley track projects over the hull of the boat several feet, so that when the head of the needle is in its proper place on the trestles the butt or foot is just at the bow. When all is ready a quick jerk on the free end of the trolley chain releases it from the claw and the weight of the needle pulls the chain over the sheave. When the needle strikes the water the current carries it against the sill, the force of the

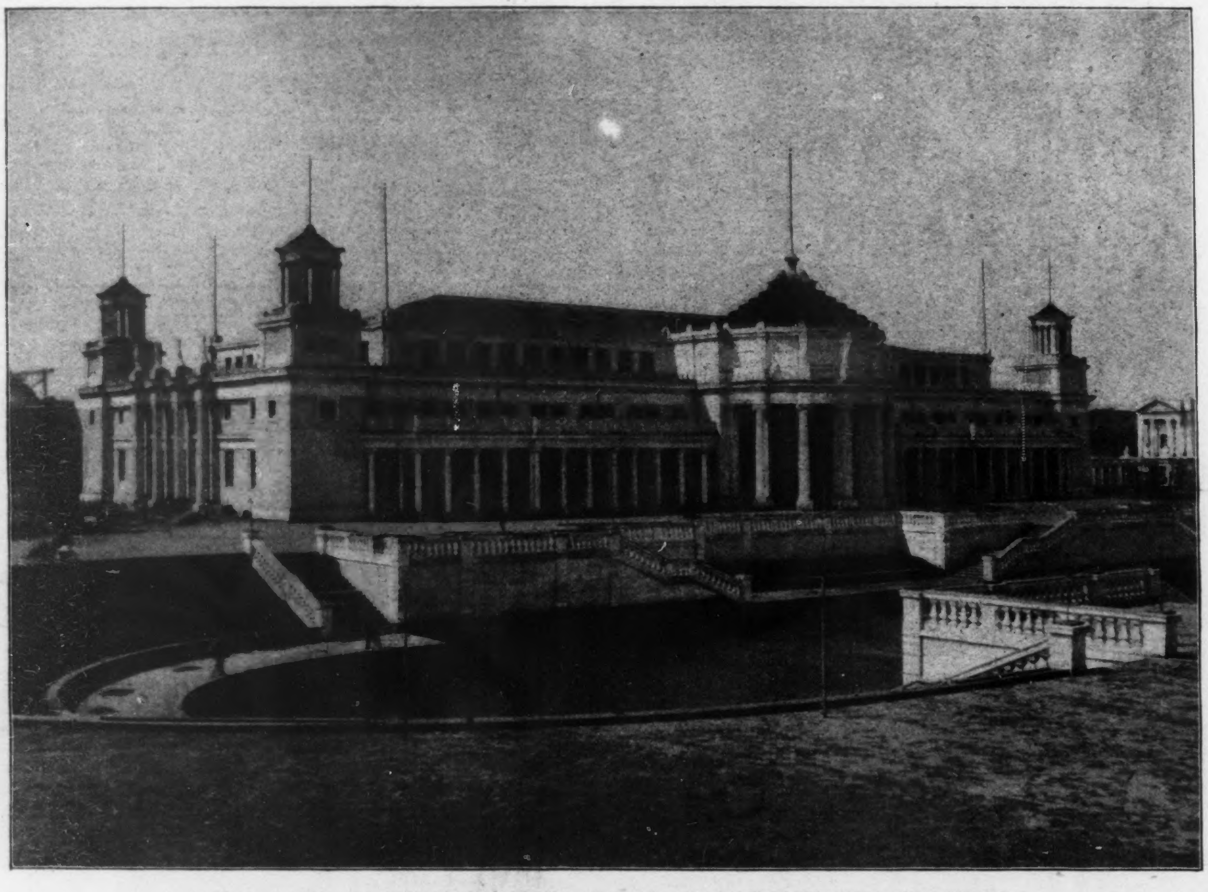

FIG. 3.—MINING BUILDING. TRANS-MISSISSIPPI AND INTERNATIONAL EXHIBITION.

blow being lessened by the men holding the free end of the chain, thus allowing it to come to place easily. As soon as the strain is off the chain, the hook drops out of the ring. A stage-plank projects about 15 ft. from one side of the boat parallel with the dam, so that it is possible to place about 30 ft. of dam by allowing the needles to float out to position without moving the boat.

(2) In the second method the needles are left in the river instead of being stored on the boat, and are lifted from the water by a light derrick on the needle boat (Fig. 6), and placed vertically, either on swinging shelves suspended on the upstream side of the trestles, or on a suitably constructed frame resting on the sill at the bottom. In placing the needles every fourth one is put in its proper place against the sill instead of on these shelves or frames. These act as guides to the others when they are let into the water, and the shelves or frames themselves prevent the needles from being carried downstream by the current (Fig. 7). After all the needles have been placed on the resting planks or frames they are dropped into the water as rapidly as practicable and the whole dam is in before the head has appreciably increased. The shelves and frames are then loosened and taken to the bank.

The weir needles are placed before those of the pass, and while there is still some water on the weir sill. This is easily and rapidly done by men standing on the masonry above the sill and taking the needles from a light boat or directly out of the river. The principal advantages of this method is that the closing of the weir increases the current through the pass and tends to scour out any deposit on the trestles which are not raised until after the weir is closed.

Removing the Needles.—When a rise approaches, the wickets in the lock gates are opened, and when they fail to keep the pool down to its normal level, alternate needles in the dam are "repoussed;" that is, the heads of alternate needles are pushed upstream and struts or sticks 12 ins. to 15 ins. long are placed between them and the support bars (Fig. 8). This permits the escape of a great quantity of water. When this fails to keep the pool down, the weir needles thus standing out may be removed entirely, or, if indications point to a considerable rise, all the weir needles may be removed. A continuation of the rise may finally necessitate the removal of all the needles standing out in the pass, or even the whole of the pass.

This last process is conducted in the following manner: Near the top of each needle is a countersunk handle for use only in removing the needle. A chain much longer than the length of the dam is passed along the upstream side of the needles and connected by hooks with these handles. There is considerable length of slack chain between each pair of handles. The end of the chain is fastened to a long line leading to the engine on the needle boat, which is anchored well upstream, or to a crab on the lock wall or on shore. By starting the engine or crab the first needle is pulled away from its support at the top, and when it has traveled the length of the slack chain leading to the next, the second is started, and so on. This maneuver is very rapid, the time required being simply that which is necessary to wind the rope on the drum of the engine.

Results of Operation.—Considerable interest is attached to the results obtained in the actual operation of this dam, and in a paper read before the American Society of Civil Engineers on March 16, 1898, by Mr. B. F. Thomas, the following information is given regarding this matter:

The dam has, at this writing, been in operation nearly one year. The early part of the present season was one of violent thunder storms and sudden freshets, which brought much driftwood into the river. About the last of July a drouth set in which was of unusual duration. The discharge of the river became reduced to less than 50 cu. ft. per second. The pool has remained full at all times, except when drawn off to assist small craft below or to perform necessary work about the lock and dam. The greatest head so far attained was 12 ft. 2¼ ins., and the leakage through the pass was only 5.19 cu. ft. per second, and that of the weir too small to take into account, being but one gallon in 38 seconds.

No trouble has been experienced with the pass; the needles have been removed and placed, and the trestles have been lowered, each time without difficulty of any kind. In raising the trestles the chain was broken on two or three occasions, caused by heavy deposits of sand on the floors which form the foot-bridge when up. With one exception this has occurred only on the trestles which lie in the pier recess. It has been found impracticable to leave the lock gates open on account of the increase of this deposit, due to the greater discharge section and consequent reduction in current velocity. By closing the lock and erecting the weir some time before the water level reaches its masonry crest, considerable scour takes place through the pass and no further trouble from this deposit is anticipated. In the pier recess the removal of the floor sections, before lowering the trestles, will prevent a deposit of sufficient weight to break the chain. On the weir there has been a little trouble with drift, but it was of slight consequence. The raising of the trestles and the removal and placing of the needles is done with the greatest facility. What difficulty there has been has arisen from permitting the trestles to stand after the removal of the needles in the drift-laden torrent caused by the release of so much water. The larger drift is held back by the boom, but small pieces, brush, etc., are drawn under the boom by the increased current, caused by opening the dam, and some of this lodges against the standing trestles. With trestles of wider span and by lowering the trestles simultaneously with the needles, most, if not all, of this difficulty can be obviated. It has not been practicable to do this, however, owing to lack of bank protection below the abutment. The opening of the needles from the abutment end of the weir causes great scour for some distance below and endangers the paving, so that it has been considered advisable to make the first openings in the dam at the pier end. Thus it was necessary for the trestles to stand until all the needles were removed, when the lowering could begin at the abutment. Even with this drawback the total delay caused by drifts has not exceeded two hours in the whole year, and but one trestle has been bent and only slightly.

On account of the great quantity of drift running in this river it was originally proposed to use wickets on the weir, raised without the use of a foot-bridge and lowered by a tripping bar; thus no trouble would be encountered by drift lodging against the trestles as now occurs on wicket dams operated from trestles. This arrangement, in the light of experience, would have been preferable, so far as disposing of the drift is concerned, but the leakage would have been more than the entire low-water discharge of the river, unless improvements could have been made over those now in use. Either method has its objections and its advantages and neither is wholly suited to a weir through which drift must pass. The only serious objection, outside of the lodging of drift on the trestles, is the difficulty of replacing the wide needles

FIG. 4.—HORTICULTURAL BUILDING. TRANS-MISSISSIPPI AND INTERNATIONAL EXHIBITION.

under the full head after they have once been removed to pass a moderate rise, but even this is not impossible and is rarely necessary. The width of weir needles can be advantageously reduced without seriously increasing the leakage and thus assist materially in this contingency.

In addition to the leakage wickets would be objectionable on this weir because they could never be put on the swing for fear of drift-wood lodging against the horses and thus complicating the maneuvers. Thus, pool regulation could not be effected in small rises with the certainty that it can by repoussing needles; but they have the advantage that they can be raised against the full head of water at any time desired, and thus prevent too great a lowering of the pool in passing small freshets. The author believes that the construction could be so altered as greatly to decrease the leakage and thus to a considerable extent eliminate this objection. Considering the untried methods necessary in this dam, it may be said that the maneuvers have all been fairly satisfactory so far. The dam has been operated in one or two instances under especially difficult conditions, and it is safe to predict success under all ordinary circumstances which may occur. A rapidly rising river, filled with drift arriving at night in snow or rain, might complicate matters considerably, and change an apparent success into a certain failure, without warning. All precautions possible, except the construction of telephone lines owned and operated by the government, have been taken to provide against surprise, and results are now to be awaited and difficulties met with courage and intelligence.

The experience so far gained with this dam indicates that its operation will be at least as speedy, easy and safe as is that of the wicket dams on the Great Kanawha or of the needle dams of the old type in Europe, while this dam is much less wasteful of water than any of these, which is an important item in this and many other streams.

Cost.—The total cost of the Big Sandy River needle dam and its auxiliary constructions was $349,155, divided as follows:

Lock	$120,372
Movable dam	76,251
Approaches, protection work, etc.	35,553
Fixed dam and abutment	26,734
Miscellaneous	29,263
Engineering, superintendence, etc.	40,440
Office expenses at Cincinnati	20,542
Total	$349,155

This total would have been considerably less if the original design had not been for a structure differing considerably from the one actually built, which acted in various ways to increase the expense. It was estimated by the engineers that under favorable conditions the dam could be built for $198,152.

A RECENT EXAMPLE OF AUTOMATIC, INTERLOCKING MACHINERY FOR OPERATING A SWING BRIDGE.

By Charles H. Wright.*

There is no more interesting work falling to the lot of the bridge engineer than the designing of the machinery for a large draw span, and there is, perhaps, no branch of his work in which such marked advance has been made in the last few years. It is no longer sufficient to provide means for rotating the span, and for supporting the ends, when the span is closed; the break in the rails at the ends of the span must be bridged over, a continuous bearing surface provided for the car wheels, and the rails clamped rigidly in line. Some form of latch must be used to assist in bringing the span to rest at the end of the return swing, and to bring the end locks into line. Danger signals must also be thrown at the ends of the bridge and at points several hundred feet distant out on the track. The machinery for performing all these movements must be under the full control of the operator in the engine-house, and many of the movements must be automatic in their action. A regular order must be followed, in performing the several operations, and the levers controlling them must be so interlocked that any variation from the fixed order of operation is impossible. Indicators attached at various points must show the exact stage of each operation at any time, as when the end lifts are fully drawn, partly driven, or with ends lifted, etc. Often a small electric light plant is installed on the bridge, and if steam power is used the little remaining space left in the engine house is taken up by the tanks and pumping machinery necessary for supplying the boilers, etc.

The interlocking and automatic devices used on a long span recently constructed by the Edge Moor Bridge Works, are shown in Figs. 1 and 2. There are three sets of friction clutches operated by the levers at A, B and C. At Y there is a set of equalizing gears for distributing the load equally to the two pinions. Fig. 1 shows the bridge closed, with all the levers locked, with the exception of lever A, which can be thrown to the right. The action briefly described is as follows:

Assume the draw closed, the ends lifted and the signals showing a clear track. If the bridge is now to be opened the first operation will be to throw the signals and draw the rail clamps. By throwing lever A, which controls the clutches S and T, to the right, clutch T is engaged and drives the line of machinery, which releases the danger signals at the end of the span, and at points 400 ft. distant. These signals are thrown by springs or counterweights, which are released by the withdrawing of an arm which upon the return movement revolves the vertical shaft to which the signals are attached and compresses the springs. At the same time that the signals are thrown to danger the rail clamps are drawn back by a system of gears and levers, controlled by the same shaft which operates the signals.

When the lever A was thrown to the right it pulled the lock bar, a, to a position where it unlocked the lever B, which operates the end lifts. The bar b, however, still locks this lever. The lever C is also locked, so that the turning machinery cannot be moved in either direction. After shaft X has revolved a certain time, sufficient to draw the rail clamps, the chain gear p has turned the worm wheel w until the projection shown on the right-hand side of the wheel strikes the arm on the fork, which is attached to shaft Y, and by revolving this shaft throws the rocker n and brings the lever A to a vertical position again, which frees clutch T, and stops this portion of the machinery. As the lever A moves back to the vertical position it brings the notch in lock bar b opposite the lug on lever B, and thus releases this lever. Lever B can now be thrown to the right, but is still locked to the left. If B is now thrown to the right, clutch P is engaged and the end lifts are drawn. This motion of B throws the lock bars c and d, which lock A, and also throws e and f, f being thrown so as to unlock lever c, while the bar e still locks it. Lever A is now locked in one direction by the bar c, and in the other by the worm wheel and rocker n. Lever C is also still locked. When the shift Z has revolved a sufficient time to draw the end lifts, the chain gearing and the worm wheels (similar to the arrangement on shaft X) throw the clutch P out of gear and brings the lever B to a vertical position again. As B moves to the vertical position it throws the bar e, which unlocks lever C. This lever can now be thrown in either direction for turning the draw.

Lever A is meanwhile locked in both directions and B in one. In closing the draw the operation just described is reversed. There are indicators which show the progress of the different operations.

The interlocking and automatic cut-off machinery was designed by Mr. Chas. H. Wright, Chief Draftsman of the Edge Moor Bridge Works, and the Moore & White Co., of Philadelphia, who manufactured this part of the machinery. It has worked perfectly.

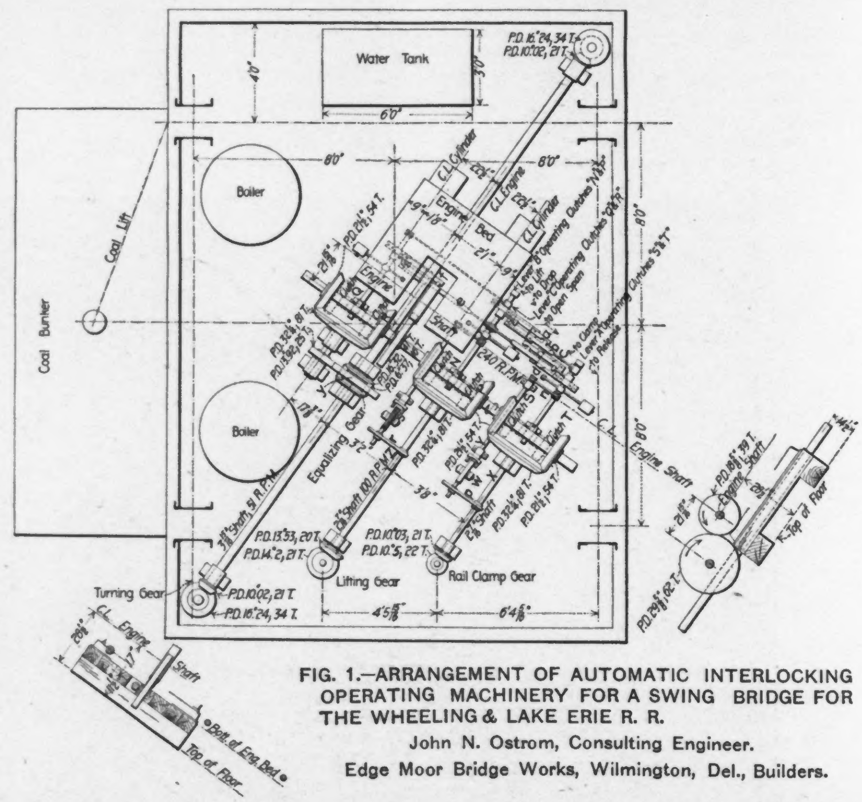

FIG. 1.—ARRANGEMENT OF AUTOMATIC INTERLOCKING OPERATING MACHINERY FOR A SWING BRIDGE FOR THE WHEELING & LAKE ERIE R. R.

John N. Ostrom, Consulting Engineer.

Edge Moor Bridge Works, Wilmington, Del., Builders.

Fuller descriptions of parts of this bridge will be found in the work on "Draw Spans" by Mr. Wright, now in press.

*Chief of Drafting Department, Edge Moor Bridge Works, Wilmington, Del.

RECENT RESEARCHES IN TERRESTRIAL MAGNETISM.

The obscure subject of terrestrial magnetism and the cause of the remarkable vagaries of the magnetic needle which occur, have been for some time under investigation by French and Russian scientists in connection with a large area in Central Russia. Recent press dispatches give some of the results of the experiments made on the country between Moscow and Kharkov, two cities 850 miles apart. It was found that the greatest aberration of the magnetic needle occurred in the Province of Kursk. At a station in the north of the Province the needle was deflected 20°, and at a place 150 miles to the southeast of the first point it was deflected 96°. At the latter station the needle pointed practically East and West, instead of North and South. The meager accounts so far received do not permit an explanation of this remarkable deflection, nor do they give any geological or other data upon which any reasonable explanation can be offered.

But, in a late paper presented to the Franklin Institute, Mr. Benjamin Smith Lyman, a mining engineer and geologist of long experience, notes a case of compass variation in Pennsylvania that seems to show some relation between magnetic and geological phenomena, in this connection. In 1883, Mr. Rudolph Hering, M. Am. Soc. C. E., made for the Water Department of Philadelphia a topographical survey of the Perkiomen Creek and the surrounding region, in Bucks and Montgomery counties. At the same time a magnetic map was made of this section, and curves of equal declination were drawn for every tenth of a degree. These curves were remarkable in their tracery; showing a fairly regular northeastward tendency or bend on an axial line which in itself bent the aggregate of lines of equal declination appearing somewhat like folds over some central object. The lines were so regular in their irregularity, and so much at variance with the simple straight lines of previous less detailed maps, that, in the absence of any obvious topographical or other known reason for their being, they were doubted by some and ascribed to mistaken observations or to lack of sufficiently accurate data.

But in 1887 a geological survey of these two counties was commenced, and a geological map was finally published, in 1893, giving the direction and amount of the dip at some thousands of points. This geological map, made without the least reference to the earlier magnetic map, beautifully confirmed the first, and by underground geology vindicated the general correctness of the observations made upon the magnetic deflection. The axis of the bend in the magnetic curves is itself greatly bent, almost at a right angle; and the geological survey has proved beyond a question the existence of an enormous fault of about 14,000 ft., lying almost exactly on this magnetic axis. The topography of the country shows no strongly marked ridge following the axis of the magnetic curves, and the long, rather high ridges run in other directions. Further, the form of the outcropping rock beds, sedimentary or igneous, does not correspond in any degree with the magnetic curves. Mr. Lyman does not believe that these curves could have been produced by any known deposits of iron ore or trap in these countries, whether they were strongly or weakly magnetic; and he adds that deposits of iron ore seldom affect the most delicate magnetic needle at a distance of more than a few hundred feet.

It is clear to him that the remarkable magnetic peculiarity observed must be closely related to the equally remarkable and completely corresponding geological structure; and this theory seems to be confirmed by the two thoroughly independent pieces of work noted. Perhaps some light is here thrown upon this obscure subject; for while the nature of the relation is not easily determined, it seems certain that the internal structure of the earth's crust has an important influence upon terrestrial magnetism. As Mr. Lyman remarks, some authorities explain this magnetism and its changes by solar influences alone; no longer considered as exerted by the direct action of the sun as a magnet, but by the heating of the atmosphere and of the earth's crust by the sun. The present experience, however, seems to point to more strictly terrestrial processes as the true cause, and to suggest that the solar influences may partly, at least, be exerted through the attraction of gravitation as well as through heat.

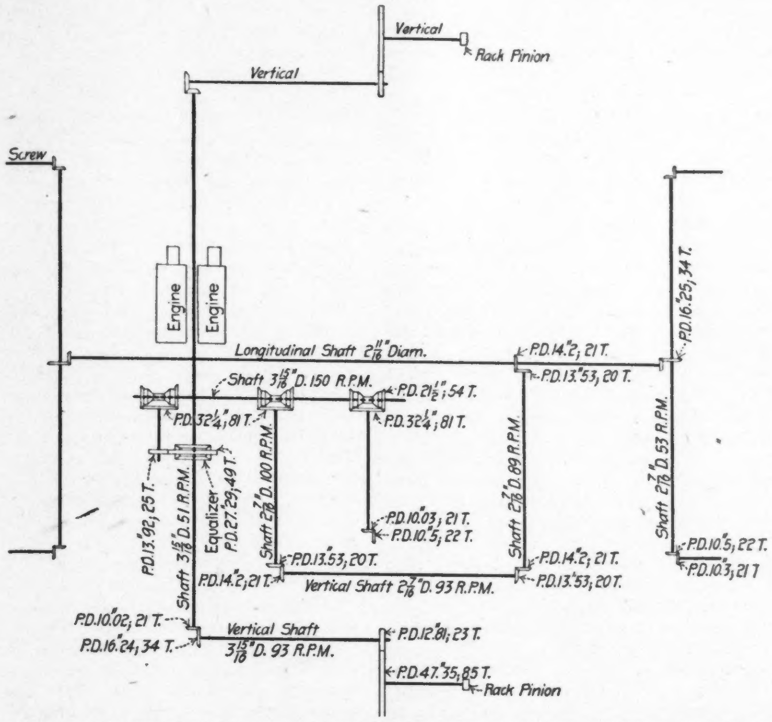

FIG. 2.—DIAGRAM SHOWING SIZES OF SHAFTING AND GEARING LEADING FROM ENGINE TO POINTS WHERE POWER IS USED.

The author thus offers the following explanation: The enormous and locally unequal strains produced by the contraction of the earth's crust in cooling would be particularly liable to be affected by the presence of a deep fault or sharp anticlinal, both present in this case. These lines would indicate a yielding of the crust, and the existence of points where the strain has been to some extent relieved. This condition is here further proven by the recent occurrence of earthquakes along the New Jersey end of this very fault line, showing that the resistance of the crust is less, and the remaining strain must likewise be less. On such a comparatively weak and yielding line the rock beds, in readjusting themselves, even without any violent earthquake, must occasion not only a certain amount of strain, but also of friction and heat, and the latter may give rise to electrical currents.

A decided magnetic effect has been found to accompany, and sometimes to precede, earthquakes; and the attraction of the sun and moon may cause electrical currents by occasioning certain strains and readjustment in the earth's crust. A temporary local variation in temperature may follow the breaking or arching of rock beds, and set up electrical earth currents. Hence Mr. Lyman concludes that terrestrial magnetism may not only arise from the action of the sun's heat on the air and crust of the earth, but also from the internal movement of the crust and the tidal effect of the sun and moon upon the air, the ocean and the earth. This is a subject well worth following out, and magnetic investigation should accompany or follow the geological survey of underground conditions. In the Pennsylvania case the maximum declination, or magnetic variation, was not quite 7°. If the peculiar curves noted in this case were either occasioned by, or in some way related to, the fault line of 14,000 ft., which so closely follows the axial line of the magnetic curve, what should be the underground conditions which accompany the enormous deflections reported from Russia? If there is any fixed relation between terrestrial magnetism and geological formation, as the Pennsylvania surveys would seem to prove, the Russian case should present exceptional opportunities for further and conclusive investigation in this field. Mr. G. R. Putnam has lately been investigating magnetic disturbances on St. George Island, in Bering Sea, and reports them practically as follows in the "Journal of Terrestrial Magnetism":

"The Pribilof Islands, in the Bering Sea, and of which St. George is the second in size in the group, are entirely volcanic in origin. The Island of St. George is about 12 miles long by 5 miles wide, and its surface is covered with lava rock and scoria, with a heavy growth of grass around the borders. During the work of the U. S. Coast and Geodetic Survey parties on this and the neighboring island of St. Paul, regular magnetic observations were made at a base station, and the declination was observed at 24 scattered points on the eastern two-thirds of the island. These declinations showed a range from 5° 14' East of North, to 20° .03' East. Another station showed a declination of 5° 54'; while at three stations within one-quarter mile, and north northeast and southeast of the summit where the first was taken, the declinations were 14° 55', 15° 38' and 15° 27'. The variations appear to be chiefly due to the magnetic properties of the local surface materials. Small pieces of the rock or scoria would deflect the needle ¼°; and around a bank of red scoria the declination varied 3° in 60 ft."

TRIAL OF SELF-PROPELLING CABS IN PARIS.

A trial of self-propelling cabs has lately taken place in Paris, including three electric and one petroleum motor. One of the first named type was really a double Victoria, says "The Engineer" in reporting the trial, entered by Bouhey & Co. It weighed 30 cwt. and ran with 60 cells weighing 32 lbs. each, developing 8 HP. It met with much trouble on the steeper Paris grades; the pneumatic tires gave way under its weight, but it finally succeeded in finishing the 37-mile course by giving the accumulators a 20-minute rest.

The course selected included one-third of bad road and steep gradients, one-third of heavy traffic streets and one-third of good roads. Nearly all the cabs proved that they were capable of making 37 miles, under the above conditions, daily for nine consecutive days. In an endurance test for the accumulator capacity the Jeantaud hansom made 53.6 miles; the Krieger cabs made from 56 to 62 miles, and the Jenatzy cab made 65 miles. On a descent of 8% most of the cabs stopped in about one dozen yards under the brakes.

In commenting on the trial "The Engineer" says that the test proved that electricity was the most suitable, cheapest and most convenient power for this type of service. But it also proved that something must be done before these cabs can be relied upon. As yet there is much tinkering on the road, and the ordinary driver cannot be relied upon to do this. With a few exceptions the vehicles tested made their daily runs at from 7.4 to 9.3 miles per hour, and some performed this work without the slightest attention. With others, however, stops had to be made for screwing up the brushes and fixing parts that had become loose or disarranged. In a Krieger cab the engineer spent 20 minutes in overhauling the cab to find why the current was interrupted, and finally discovered the fault in one of the accumulator connections. If an expert spent this time in finding a defect what could be expected of an ordinary driver? The mechanism must be made stronger and simpler and more reliable before the electric cab can be depended upon.

As to the pneumatic tires, in hard daily use these last about six months. The first cost of an electric cab is heavy; but in Paris the cost of electric power is 6 cts. per kilo-watt, and that of petroleum spirit is 11 cts. per liter, and as a consequence the electric vehicle is more economical in the end.

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

GEO. H. FROST, - - - - - - - - PRESIDENT.
D. McN. STAUFFER, - - - - - - - VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
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ALFRED E. KORNFELD, New York, F. A. PECKHAM, Chicago, S. B. READ, Boston, } 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 18. 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.

The complete destruction of the Spanish fleet of armored cruisers and torpedo boat destroyers off the coast of Santiago, Cuba, on Sunday, July 3, by the United States fleet under Commodore Sampson, is an achievement of American arms, and we believe we may truly add of American engineering, unparalleled in modern naval history. The four armored cruisers sunk were among the finest naval vessels afloat. They had heavy armor belts of Harveyized nickel steel, guns and armament almost equal in power to those of our own battleships, and engines which should have enabled them to outrun any United States vessel afloat except the "Columbia" or "Minneapolis." Yet in the naval battle which followed the attempted escape from Santiago Bay, the Spanish vessels were unable to outrun the American; they were pierced by shot and shell until their crews could no longer fight them, and, most astonishing of all, their guns inflicted hardly a single injury upon the vessels of the attacking fleet.

When the United States victory at Manila was proclaimed, unfriendly European critics were not slow to say that the Spanish ships in that action were mere old tubs, unfit for fighting. We showed in our issue of May 12 that while our ships at Manila were unquestionably better vessels, the armament of the Spanish vessels was not so very much inferior to ours, and neither fleet had armor that could be expected to prove effective in keeping out anything but the smallest projectiles.

Our foreign critics have now to reflect on the fact that in another naval battle, nine weeks after the battle of Manila, four of the best vessels afloat in the Spanish or any navy are sunk or driven ashore in a sinking condition or on fire, with hundreds of their crews killed. On the American side one man killed marks the total of casualties.

Our esteemed contemporary, "The Engineer," of London, in its issue of June 3 appeared to think that the entry of Cervera's fleet into Santiago was a great piece of generalship on the part of its commander. We remarked a fortnight ago that this was the place of all others where the American commanders wanted him to go, and we presume "The Engineer" understands by this time the reasons for our assertion.

In this connection we are interested to note that in its June 24 issue our contemporary declares that "the war is rapidly reaching a ludicrous stage. Every natural item that can be invented has already been invented by the American Press."

We acknowledge that the great inventive powers usually accredited to Americans are shared by our newspaper reporters; but they have not had time to do much inventing this week. Recent events may also seem ludicrous to "The Engineer," but we very much doubt whether the Spanish people will find anything in them of a ludicrous nature. Nor is there anything ludicrous to Americans in the condition of a defeated foe. For Spain's unfortunate soldiers and sailors and for her common people, Americans have genuine sympathy; and they deeply regret that in order to put an end to a century old system of misgovernment and oppression this government has been forced to add to the sum of their sufferings.

At the outbreak of our present war with Spain the fleet of torpedo boat destroyers belonging to the latter nation was the occasion of much uneasiness on this side of the Atlantic, not only among the people at large but in our navy itself. We had no vessels at all of this class, while those of Spain were of the latest English models and build, thoroughly equipped, of great speed, and credited with a capacity for untold mischief to our slow and heavy ships of war as soon as fate should bring them together. These fast destroyers, rather than the cruisers of Cervera's fleet, were supposed to be the dangerous element in the attack upon our battleship "Oregon," which was at one time deemed possible; and even after Cervera's fleet took refuge in the Bay of Santiago there was always a chance that these fleet little war engines would dash out and make trouble for the United States vessels outside. Naval authorities of all nations anxiously awaited the results of the battle between destroyers and battleships, neither of which had been fairly tested in modern naval warfare, and the general impression among the Continental powers was that it would be the United States that would be badly hurt.

The result of two months' experience with torpedo boats and "destroyers"—as handled by Spaniards—is almost ridiculous. At Manila some torpedo boats made a brave and reckless dash at the ships of Admiral Dewey, but they were met by such a hail of well-directed rapid-fire projectiles that they were riddled and had to turn and run for the beach. At San Juan, lately, a torpedo boat destroyer, one of the finest afloat, came out and attacked a converted Atlantic liner, but she was forced to turn back in a sinking condition, with part of her crew killed, before she could get near enough to her opponent to discharge a torpedo.

Later still, when Cervera's fleet made the desperate dash out of Santiago Harbor, two of the destroyers ran toward the "Brooklyn" with the apparent intention of torpedoing her. Before they could carry out their purpose, however, they were both attacked and sunk by the "Gloucester," a converted pleasure yacht formerly known as the "Corsair" and owned by Mr. J. Pierpont Morgan. Admiral Cervera is said to have given way to tears when a few minutes later he found himself a prisoner of war on this same "Gloucester," and it is small wonder if he did. His four very powerful and heavily armored warships had all been sunk without damage to a single ship of the enemy and with only one man killed on the entire American fleet; and he found himself a prisoner on board the very vessel, a mere pleasure yacht, that had destroyed two of his redoubtable "destroyers."

While a different story would probably follow an attack of torpedo boat destroyers when manned by English or American sailors and with their movements directed by officers of either of these nations, there are some lessons to be learned from the fate of the Spanish vessels of this class. The first is that with rapid-fire batteries properly handled by men who can shoot, and hit what they shoot at, there is every probability that a destroyer can never come near enough to the enemy to inflict any damage with her torpedoes. The destroyer is a fast but very vulnerable craft, but the projectiles of modern guns are far faster, and a very few of them of moderate caliber are capable of putting her out of action. Many naval authorities have long agreed that the proper function of torpedo vessels is in night attacks; but the recent perfection of naval searchlights has greatly lessened the chances of torpedo boat success even in the night time.

It will not be strange if experience with torpedo vessels in the present war should lead to the naval powers assigning them less prominence in their armaments. At the same time it must be fairly said that the lesson of the war which is far more strongly emphasized is that neither personal bravery nor the possession of powerful vessels can compensate for the lack of mechanical skill, good marksmanship and able generals.

The conclusions of the special committee report on "Tests for Constant Volume of Portland Cement" that was presented at the annual meeting of the Association of German Portland Cement Manufacturers in February, 1898, which is quite fully reported elsewhere in this issue, should, we think, be accepted with some reservation by American engineers. The committee, it will be noted, asserts bluntly that in its opinion accelerated tests are of no value in determining the durability of cements in practical use. If the committee means by this that in their present experimental stage the adoption of accelerated tests in cement specifications generally is of very doubtful wisdom, we think that most engineers who have studied the matter carefully will agree with it. But if the committee means to convey the impression that its experiments have shown accelerated tests to be entirely without promise of merit, its conclusions are open to grave doubt. Unfortunately all the data of the committee's investigations are not available for study, but judging from the abstract of the report furnished to us it seems to base its conclusions upon the fact that the cements selected for study stood the ordinary short time cold water test, and also, when made into large disk shaped medallions, endured uninjured an exposure of 1½ years in air despite the fact that the majority failed to withstand the boiling and hot water tests of Michaelis, Tetmajer and Maclay. With this evidence alone and with the record of previous tests in mind it may, we think, be fairly said that the conclusions of the committee do not stand proven. The fact that the cement pats tested by it withstood the cold water test has no place in the argument at all, for the reason that the advocates of accelerated tests deny the efficiency of the cold water test. On the other hand, the durability of the cement and sand medallions exposed 1½ years to the atmosphere is admissible evidence. It is, however, not conclusive evidence that the test pieces would not have failed ultimately. In the elaborate tests made by Prof. Tetmajer (Eng. News, Oct. 31, 1895), the majority of the cement pats exposed to air failed only after a year's time, and if we are not mistaken some of them lasted nearly three years but ultimately disintegrated. It may be possible that a longer exposure of the medallions in air would have confirmed the showing of the accelerated tests that the cements were unreliable. We are far from the opinion that the value of heat tests has been conclusively shown, but the evidence of most of the tests which have been made, and the attitude of such bodies of experts as the "German Conference Upon the Methods of Testing" and the "French Commission Upon Methods of Testing," speak strongly enough in their favor to warrant engineers in awaiting conclusive proof of their worthlessness before discrediting them altogether.

The municipal art number of "Municipal Affairs" deserves a word of special mention. This is a subject which has hitherto received scarcely any attention by the vast majority of our American cities. Perhaps more has been done in this way in connection with city parks than in any other manner, but even that has often been largely incidental to the main and proper object of providing places where people could get near to

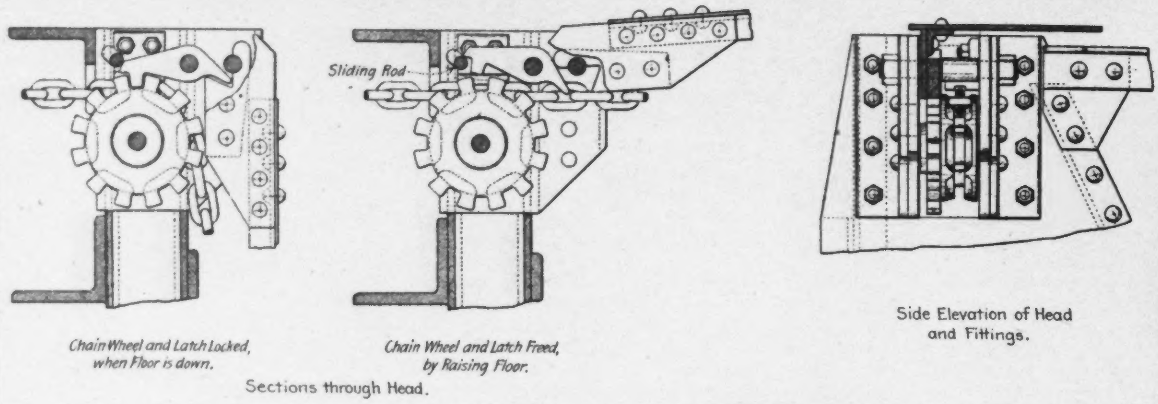


FIG. 5. DETAILS OF HEAD OF TRESTLE SHOWING OPERATION OF HOISTING CHAIN.

FIG. 1. VIEW OF DAM AND LOCK FROM
(This view shows the pool 3 ins. above the
is 12 ft. 3 ins. fr

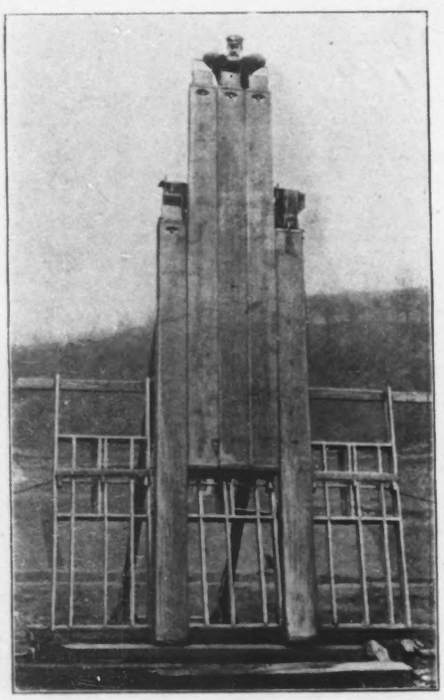


FIG. 7. VIEW OF TRESTLES SHOWING FRAME SUPPORTING NEEDLES READY TO TRIP.

(The needles shown to the right and left against the sill are for guides.)

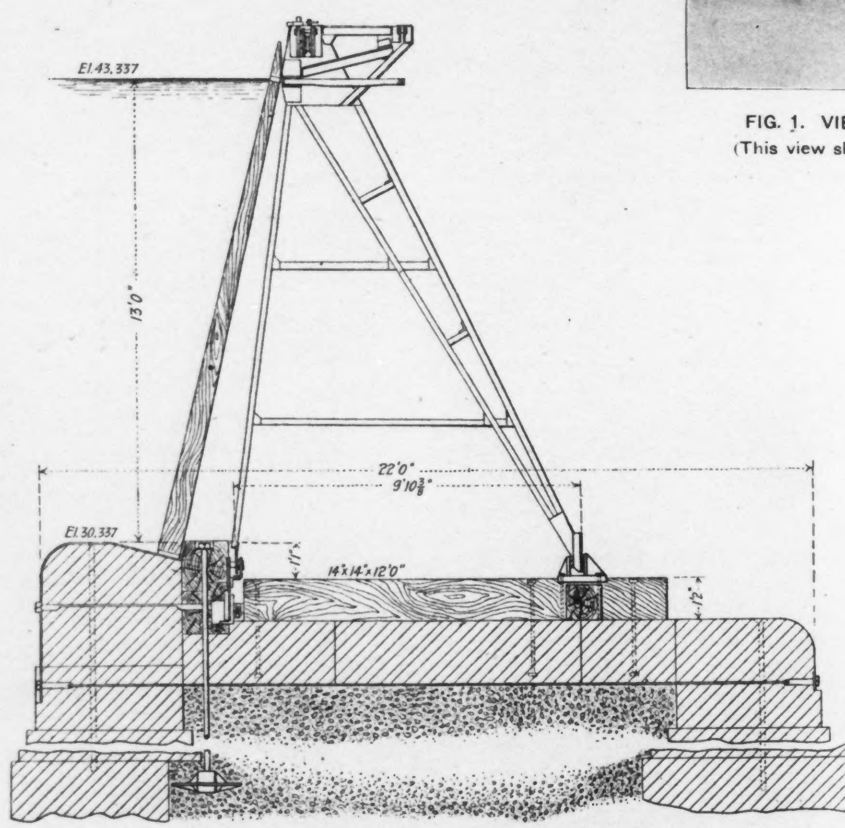


FIG. 2. TRANSVERSE SECTION THROUGH PASS.

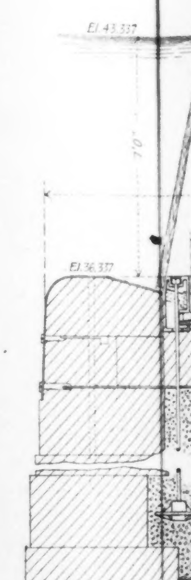


FIG. 3. TRANSV

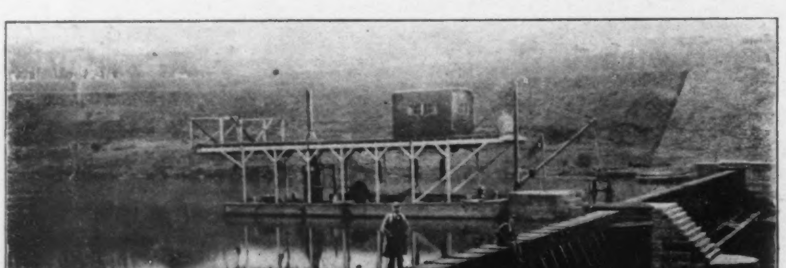


FIG. 6. VIEW OF DAM FROM BELOW SHOWING BOAT FOR HANDLING NEEDLES.

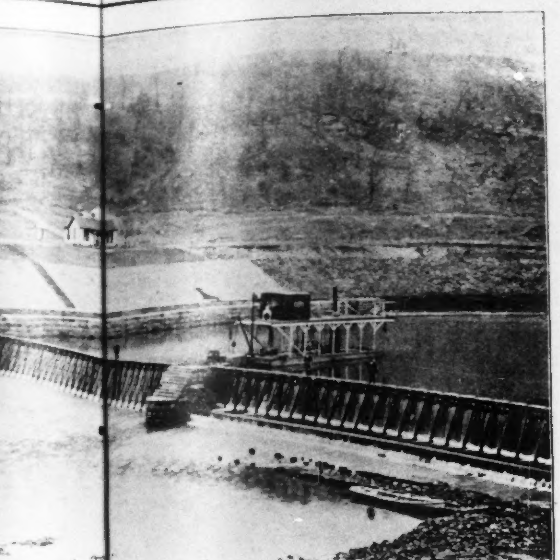
(The head or difference in level between the two pools is 12 ft. 2 ins.)

POIREE NEEDLE DAM ON TH

AT LOUISA,

Major James F. Gregory, U. S. A

B. F. Thomas, M. Am. Soc. C. E., U



AM AND LOCK FROM BELOW ON THE KENTUCKY SIDE.
pool 3 ins. above the normal level and running over. The head is 12 ft. 3 ins. from pool to pool.)

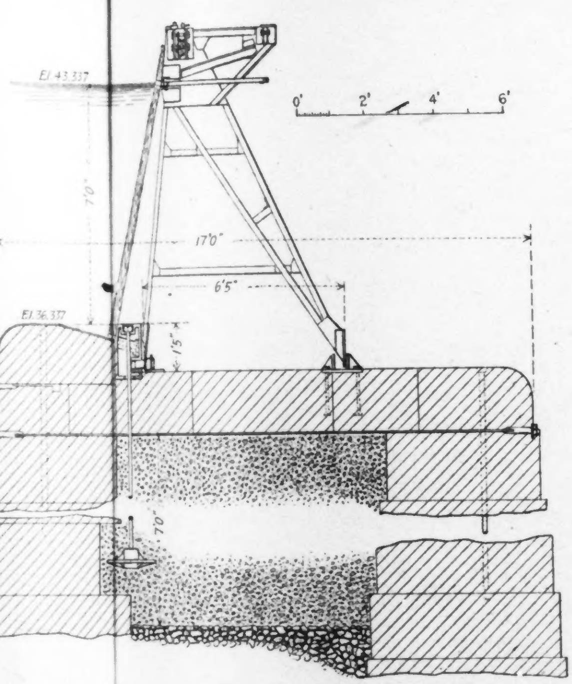


FIG. 3. TRANSVERSE SECTION THROUGH WEIR.

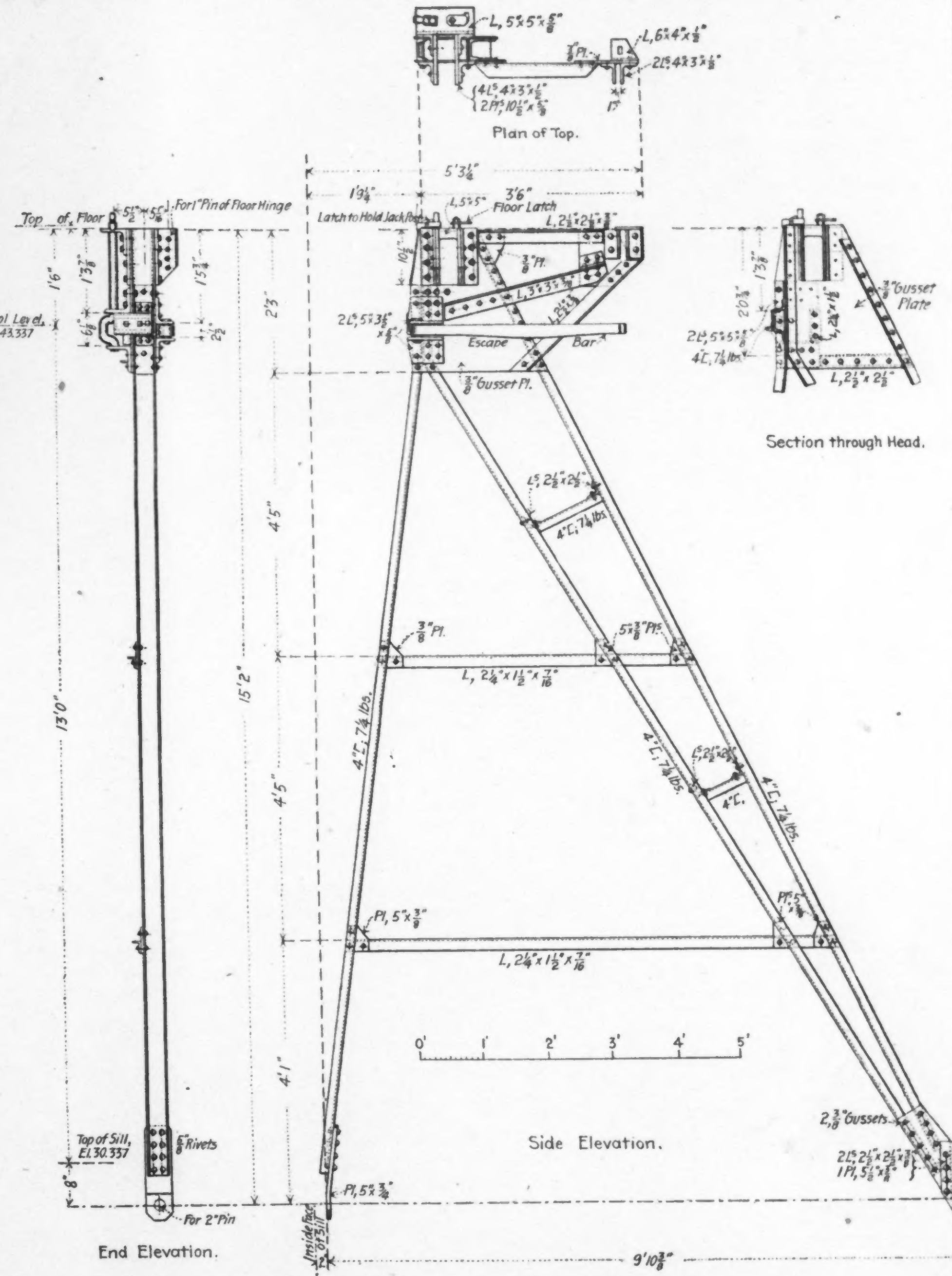


FIG. 4. GENERAL DETAILS OF PASS TRESTLE.

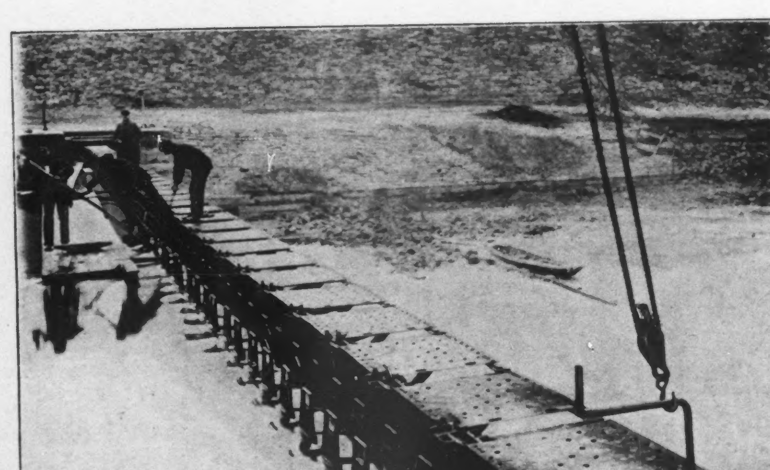


FIG. 8. VIEW SHOWING NEEDLES PUSHED BACK AND BLOCKED.
(This is done to waste water on a rising river.)

E DAM ON THE BIG SANDY RIVER
AT LOUISA, KY.

Gregory, U. S. A., Engineer in Charge.
Am. Soc. C. E., U. S. Assistant Engineer.

nature rather than study art. Next to parks, and perhaps ranking first, municipalities have made an attempt at the artistic when providing themselves with city halls and school buildings, but here the results have more often than otherwise been disappointing, quite commonly through mistaking ostentatious display for artistic expression. The articles in the journal in question, which are mentioned more particularly under our New Publications, show the wide range of possibilities for municipal art, embracing the plan of the city; the material and character of its buildings, both public and private, including color effects; sculpture for parks, public places and buildings; mural paintings, and, finally, even such details as street signs, flags and banners. A radical change in municipal art might be accomplished without adding materially to city expenses. In fact, beauty would be cheaper than much of the ugliness so apparent in many of our cities. Art often depends more upon an appreciation of the appropriateness of things than upon the expenditure of additional sums of money. We should all do what we can as cities and as individuals to cultivate an appreciation of municipal art.

The new needle dam on the Big Sandy River, near Louisa, Ky., which is fully described elsewhere in this issue, calls deserved attention to the very high character of some of the engineering construction which is now being done by Government engineers in developing slack water navigation on the rivers of the Ohio Valley and the South. This dam not only sustains a greater head of water than any dam of the same type previously built, but, what is of greater importance, its very successful operation with this unprecedented head gives promise that movable dams, if properly designed, can be built and operated with still greater lifts at a cost which is not exorbitant compared with that of fixed dams when we take into account the obvious advantages of the movable structure for securing slack water navigation. The object of damming a navigable stream is simply to conserve the water during the season of medium flow so that navigation can still go on uninterruptedly through the lock which is provided for that purpose. With a fixed dam the navigation must of course pass through the lock at all times, while with a movable dam it is possible upon the approach of sufficient water for free navigation to restore the stream to its natural condition by lowering the dam and thus throw the whole width of channel open to the passage of craft. This is a very material advantage in the case of many of our inland rivers where slack water navigation exists. A large bulk of the traffic in these streams consists of the shipment of coal in barges and lumber on rafts, which accumulate in vast quantities in periods of low water waiting for the first rise to take them to their destination. If the rise is of short duration the delay caused by passing everything through the lock may result in the failure of many of the accumulated craft to receive any benefit from the long-watched-for flood waters. Still another adadvantage of the movable dam is that in times of freshet it does not raise the flood level above its accustomed height in the original condition of the stream, and can therefore be applied safely to much higher lifts than can a fixed dam.

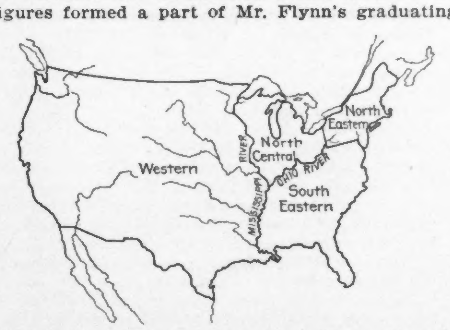
The one great drawback of movable dams, however, has been their expense, the explanation of which recent authorities have come to believe is to be found in the fact that they have nearly always been built with lifts which would allow of the needles being placed and removed by hand. Such a restriction of course makes the cost very great in proportion to the length of river made navigable, for the reason that the cost of the foundation and substructure, which constitute the bulk of the cost of a movable dam, is largely independent of the height of superstructure placed upon them. The most paying efforts in the direction of future improvements in movable dam construction, therefore, are those which lead to increasing the practicable lift with which they can be operated, and it is because of its decided advance over other dams in this regard that the Big Sandy River dam is particularly instructive.

The successful operation of this dam against a head of water of 12 ft., or nearly twice that of any previous dam, is made possible, as the article published elsewhere clearly shows, by the use of special appliances to handle the trestles and to place and remove the needles. In its broad features of design and operation the dam does not differ materially from the low lift needle dams constructed in many places both in the United States and Europe, but while previous dams have been kept pretty rigidly within that limit of height which would allow of the needles being maneuvered by hand, the Big Sandy River dam has been provided with machinery capable of handling needles of great weight and size, and the advantage thus gained has been utilized to increase the height of lift. There seems to be no insurmountable reason, moreover, why still more powerful and better adapted mechanism for operating the needles and trestles cannot be designed and employed, with a further gain in the height of lift with which a needle dam can be operated.

The negotiations between the Manhattan Ry. Co. and the New York Rapid Transit Commission looking to extensions of the Manhattan Elevated Ry. system in New York city, which have been proceeding for some months, have finally come to a halt, and from present appearances are not likely to be resumed until Fall, if indeed they are not permanently closed. The rock on which the negotiators split was the rental of 5% of the gross receipts fixed by the Commission for the proposed line on West St. connecting with the Jersey City ferries and crossing the city at 13th St. to junctions with the present north and south lines of the system. Public opinion will probably be divided as to whether the Manhattan Co. really believed the rental asked for the franchise was more than it was worth; or whether it relied on the fact that it was the only bidder for what the city had to sell, to force down the price. The supercilious and insulting tone adopted, in the negotiations with the Rapid Transit Commission, by the young multi-millionaire and the sage dealer in puts and calls who control the destinies of the Manhattan Company, incline an unprejudiced observer to the latter view.

SOURCES, MODES OF SUPPLY AND FILTRATION OF PUBLIC WATER SUPPLIES IN THE UNITED STATES.

Through the courtesy of Mr. Benj. H. Flynn, of the graduating class of the University of Ohio, at Columbus, O., we are enabled to present a summary of the sources and modes of the public water supplies of the United States and the number and kind of the filtration plants in use. The figures formed a part of Mr. Flynn's graduating



Sketch Map Showing Groups of States Used in Summarizing Water Supply Statistics.

thesis. They were compiled from "The Manual of American Water-Works" for 1897. As originally tabulated the figures were so presented as to give the data separately for cities of six different sizes in four sections of the country. We have omitted the classification by populations, giving only the totals by groups of States. The boundaries of these groups are indicated on the accompanying map. In table I. we have added the three columns of sub-totals, and Table III. has been rearranged.

Perhaps the three most striking things shown by Table I. are: (1) That 1,822 of the 3,356 sources of supply are wholly ground water; (2) that nearly all the filtration plants are connected with surface supplies, and (3) that while in some foreign countries nearly all surface supplies are filtered, this being practically required by law in Germany, in the United States only 14 per cent. of the surface supplies have even the name of being filtered. That some of the so-called filtration plants are of no real value is a fact spoken of further on. It is true that many of our surface supplies are from such sparsely settled, rocky and wooded districts as to insure great natural purity, but this by no means accounts for the difference in practice between our own and foreign countries. There are indications that we are on the eve of a great change in this respect. Many filtration plants are under construction or proposed, and at the water-works conventions it is becoming more and more common for speakers to state as their opinion that in the future all surface supplies must be filtered. It is not organic matter or sewage pollution alone that makes filtration of surface waters necessary or desirable. Turbidity and color are objectionable to say the least. In practically all of the Southeastern section, in much of the North Central, and in all but the mountainous portion of the great Western section, and even in some parts of that, turbidity is present in all surface waters, and at times is almost intolerable. Settling reservoirs are employed in many cities, but on the whole they are comparatively few in number and diminutive in capacity, besides which they must in many cases be supplemented by filtration if an agreeable water is to be supplied.

Although so few of our ground water supplies are being filtered, by no means all of the remainder are above suspicion of sewage pollution, and later years will doubtless show a great increase in filtration plants for the removal of iron, of which some half dozen or less have been built.

The large number of ground water supplies in use, coupled with the many plants where water is pumped to reservoirs, shown by Table III., suggests another broad field for engineers and contractors; the covering of storage reservoirs. Of course not all the reservoirs indicated in Table III. are used to store ground water, but some storage, even if small in amount, is frequently provided wherever ground water is used. When exposed to the sun such water is likely to give rise to various organic growths which, while entirely harmless in themselves, cause very unpleasant tastes and odors. Such troubles can often be avoided by covering the reservoirs. The practice is common abroad but has been followed but little here, especially for large reservoirs. Roofs or coverings in Europe have commonly been of masonry, and it has often been thought, essential to have the covering surmounted with earth, thus increasing the load to be borne. Most reservoir coverings in this country have been of wood. So far as we know they have served their purpose very well, but whether as well in all cases as masonry, and whether they will prove as cheap as masonry in the long run we will not attempt to say.

Before leaving Table I. it should be said that of the 502 sources of supply credited to springs probably some are quite as truly surface waters, spring water having so very attractive a sound that it is sometimes applied to water from small streams which, while undoubtedly spring-fed, yet derive a goodly portion of their yield from surface flow. It is also true that many surface supplies are greatly augmented by springs.

The number of filtration plants of the various types is shown by Table II. The total here is 60 greater than in Table I., owing to that number of filter galleries added to this table. It must not be understood that there are 291 (or 231 on omitting the galleries) efficient filtration plants in the United States. Practically all of the 66 plants under the heading "Miscellaneous" and some of those under "Sand Filters" really ought not to be classed as filter plants, being at best only screens, and in some cases poor ones at that. Doubtless there are 126 mechanical filter plants in the country. The majority of these were put in to improve the appearance of the water rather than to remove organic pollution, but some of them are doing good work in both lines, and probably all, or nearly all, are greatly improving the water in one way or another. As to the actual number of effective sand filters in use it may be said that the June issue of the Journal of the New

TABLE I.—Sources of Water Supplies of Cities and Towns in the United States, Divided into Unfiltered and Filtered.*

		Surface: Rivers.	Surface: Lakes.	Surface: Impounding reservoirs.	Surface: Rivers and lakes.	Surface: Rivers and impounding res.	Surface: Total.	Ground: Wells.	Ground: Springs.	Ground: Galleries and tunnels.	Ground: Wells & springs.	Ground: Wells and galleries.	Ground: Springs and galleries.	Ground: Wells, springs and galleries.	Ground: Total.
Northeastern	Unfiltered	276	122	128	12	3	541	167	293	8	25	4	..	3	500
	Filtered	60	7	7	0	0	74	2	7	1	1	0	..	0	11
	Total	336	129	135	12	3	615	169	300	9	26	4	..	3	511
Southeastern	Unfiltered	97	5	16	..	1	119	100	71	..	8	..	..	..	179
	Filtered	19	1	4	..	0	24	0	1	..	0	..	..	..	1
	Total	116	6	20	..	1	143	100	72	..	8	..	..	..	180
North Central	Unfiltered	91	58	9	2	..	160	407	25	11	13	5	1	..	462
	Filtered	26	4	3	0	..	33	1	2	1	0	3	0	..	7
	Total	117	62	12	2	..	193	408	27	12	13	8	1	..	469
Western	Unfiltered	220	22	37	0	2	281	521	103	13	11	8	1	1	658
	Filtered	36	2	9	1	0	48	4	0	0	0	0	0	0	4
	Total	256	24	46	1	2	329	525	103	13	11	8	1	1	662
Grand total	Unfiltered	684	207	190	14	6	1,101	1,195	492	32	57	17	2	4	1,799
	Filtered	141	14	23	1	0	179	7	10	2	1	3	0	0	23
	Total	825	221	213	15	6	1,280	1,202	502	34	58	20	2	4	1,822

		Surface and ground: Rivers and wells.	Rivers & springs.	Rivers and galleries.	Rivers, wells and impounding res.	Rivers, wells and springs.	Rivers, wells and galleries.	Lakes and wells.	Lakes & springs.	Lakes, wells and springs.	Impounding res. and wells.	Impounding res. and springs.	Total.	Grand total.
Northeastern	Unfiltered	19	53	2	1	3	2	4	4	1	6	1	96	1,137
	Filtered	8	4	0	0	0	0	0	2	0	2	0	16	101
	Total	27	57	2	1	3	2	4	6	1	8	1	112	1,238
Southeastern	Unfiltered	7	7	..	..	1	..	..	..	..	..	1	16	314
	Filtered	1	0	..	..	0	..	..	..	..	..	0	1	26
	Total	8	7	..	..	1	..	..	..	..	..	1	17	340
North Central	Unfiltered	28	4	..	..	3	1	11	..	4	..	..	51	673
	Filtered	1	0	..	..	0	0	1	..	0	..	..	2	42
	Total	29	4	..	..	3	1	12	..	4	..	..	53	715
Western	Unfiltered	32	16	2	..	2	1	3	..	..	4	2	62	1,001
	Filtered	6	0	1	..	1	0	1	..	..	1	0	10	62
	Total	38	16	3	..	3	1	4	..	..	5	2	72	1,063
Grand total	Unfiltered	86	80	4	1	9	4	18	4	5	10	4	225	3,125
	Filtered	16	4	1	0	1	0	2	2	0	3	0	29	231
	Total	102	84	5	1	10	4	20	6	5	13	4	254	3,356

*Filtered supplies do not include those where the water is collected by filter cribs and galleries, of which there are 60, as shown by Table II.

England Water-Works Association contains a list of 14 plants, compiled by Mr. Allen Hazen, Assoc. M. Am. Soc. C. E., and including all which he deemed worthy of the name. Some of these, we believe, were not in use when the "Manual" was published. It is quite probable that some of the 25 plants which are in Mr. Flynn's list but not in Mr. Hazen's are doing fairly good work, at least as good as some of the mechanical filter plants. Filter galleries, in many instances, are designed more to develop a supply than to filter one, in which case they are comparable with driven wells. These comments on the filtration statistics are not to be taken as reflections on either Mr. Flynn's work or on the "Manual," as each aimed to give such information as was available for what it was worth.

Little need be said regarding Table III. except to call attention to the number of water-works relying wholly upon direct pumping, 418, and the number of stand-pipes (which term includes tanks) in use, 1,465 in all, not allowing for the fact that there are two and sometimes more of these structures connected with some water-works. It would be interesting to see a classification of stand-pipes by material and date of erection, and to note the exact majority of steel over iron in the last few years. As against 1,465 works in which water is pumped to stand-pipes there are but 671 instances of pumping to reservoirs. Of course there are hundreds of additional reservoirs used on gravity supplies, nearly one-fourth of all the water-works in the country depending on gravity works alone.

TABLE II.—Number of Water Filtration Plants of Various Types in the United States.

	Filters—Mechanical.	Filters—Sand.	Miscellaneous.*	Filter galleries.	Total.
Northeastern	46	22	32	20	120
Southeastern	21	2	3	4	30
North Central	24	6	12	20	62
Western	35	9	19	16	79
Total	126	39	66	60	291

*Miscellaneous includes gravel screens and embankments and all supplies reported as filtered without stating the method.

TABLE III.—Number of Cities and Towns in the United States Supplied with Water by Gravity, Pumping Direct, Pumping to Stand-Pipes* and Reservoirs, and by Combinations of Such Methods..

	Northeastern.	Southeastern.	North Central.	Western.	Total.
Gravity	490	41	11	194	736
Gravity and pumping					
Direct	62	7	2	15	86
To reservoir	38	1	2	13	54
To stand-pipe	11	2	2	5	20
Direct and to reservoir	1	0	0	1	2
" " " stand-pipe.	3	1	3	1	8
To reservoir & st'd-pipe	4	0	0	8	12
Total	119	11	9	43	182
Pumping					
Direct	74	33	221	90	418
To reservoir	128	62	79	114	383
To stand-pipe	245	139	218	358	960
To reservoir & st'd-pipe.	26	11	14	20	71
Direct and to reservoir	33	11	27	45	116
" " stand-pipe.	41	20	115	185	361
" " res.& std-p	3	2	18	10	33
Total	550	278	692	822	2,342
Natural pressure	0	9	2	10	21
Grand total	1,159	339	714	1,069	3,281

*Stand-pipes includes all tanks and metal structures to which water is pumped.

The distribution of the various sources and modes of supply by sections is interesting, as may be seen by referring to the tables.

Two interesting facts brought out by Mr. Flynn's population groupings may be noticed: (1) That only two places with 50,000 population or over, and only eight with over 25,000 population are getting their supplies wholly by gravity, and (2) that five places with more than 50,000 inhabitants and 19 with more than 25,000 are depending wholly upon direct pumping. The towns having a population of 5,000 or less contribute 656 of the 736 gravity supplies, 291 of the 418 direct pumping works and 847 of the 960 works where water is pumped to stand-pipes, none of the combined systems being included in any of the figures. It should be borne in mind that these towns of 5,000 or less make up 2,569 of the 3,281 public water supplies included in Table III.

In conclusion it may be said that the figures we have reviewed indicate the vastness of the water-works interests of the country and give some hints of the opportunities for further improving our public water supplies, especially in the matter of quality.

LETTERS TO THE EDITOR.

The Graham Automatic Draw-Bar Height Adjuster.—Correction.

Sir: In the brief description of our automatic draw-bar height adjuster in your issue of June 16 we wish you would correct the statement that it is not in general use. We have been equipping our trucks since June, 1894, with this device, and it is in service in both the United States and France. Car builders to-day have to meet two very great difficulties, keeping the draw-bars at a proper height from the rail, and finding ample space between car and truck so they can increase the depth of both car and truck bolsters to provide for the increased carrying capacity. Our adjuster will permit increasing the general height of the car from the rail fully 6 ins. and comply fully with the law, which states that the draw-bar on an empty car must not be higher than 34½ ins. With our adjuster, when the car is loaded and the springs are deflected 3 ins. the draw-bar would be 37½ ins. from the rail, a difference of 6 ins., which is a clear gain for the car builder in which to increase his bolsters. The adjuster will never drop the draw-bar below the point set when car is empty, and as the load always carries the draw-bar upward, there is no fear of having it below the minimum 31½ ins. The law has not said anything about how much above 31½ ins. the draw-bar of a loaded car must be; it simply states that it must not be below 31½ ins., therefore anything above that point is within the requirements of the law. Sincerely, The Graham Equipment Co.

Boston, Mass., June 21, 1898.

A Theory for Placing Stiffeners in Plate Girders.

Sir: In your issue of June 9 there appears a criticism by "E. M." of Mr. Beach's letter (Eng. News, May 19) on stiffening plate girders which deserves some comment. In attacking the views of another the burden of proof rests with the critic, and this "E. M." seems to have entirely forgotten while making his assertions. Thus he asserts that the analogy between a stiffened plate girder and a Pratt truss exists neither in theory nor in fact, as Professors Johnson and Burr have pointed out that it did not, but he fails entirely to offer proof himself or to state where these authorities have given it.

A careful study of the discussion on the internal stresses in the stiffened plate girder brought out by Mr. Joseph M. Wilson's paper on "Specification for Iron Bridges" (Trans. Am. Soc. C. E., 1885) is disappointing indeed, since the eminent mathematicians who took part in it appear to have expended their energy rather in trying to decide what the master mind of Rankine might or might not have thought on the subject than to solve the problem themselves.

In discussing the condition of internal stress in any given structure it is well to bear in mind that it is not a Professor but Dame Nature herself that actually determines the stresses, and that the Professor, notwithstanding his learning, is frequently a forgetful fellow, leaving out of consideration a few of the practical conditions of the problem and thus arriving at conclusions inapplicable to the case in hand. Dame Nature, on the contrary, not only understands fully how to allow for all practical conditions, but never forgets them, and the result is that her determinations are ever rational and accurate beyond question.

Moreover, she is ever a willing teacher, ready to answer all questions to him who but possesses the ingenuity to ask them in the right way, and she frequently discloses her methods to the practical observer.

Evidently the first step towards arriving at a rational method of proportioning stiffness is a rational analysis of the internal web stresses of the stiffened girder. The treatment of this subject in most of our text books is of little value, since their authors have apparently forgotten the practical condition that when the stiffeners are riveted to the web they form a part of it, and cannot therefore be disregarded in any logical analysis of the internal web stresses.

About nine years ago, while looking over a girder viaduct, the writer noticed a web plate slightly buckled in the end panel of a deep girder, and just then a heavy freight train coming upon the girder this buckle appeared to pull out flat for a width of about a foot along the tensile diagonal of the panel, indicating action similar to a Pratt truss as the buckle resumed its previous form after the train had passed. The correctness of this observation appears to have been verified by a laboratory experiment, noted in your issue of Oct. 28, 1897. The buckled web of the girder used in the experiment referred to was regular in form, so that its distortion under load indicated the direction of the maximum web stress beyond question.

In stating that the proportioning of stiffness and also the spacing of them is merely a matter of guess (empiricism), and that Mr. Beach's guess is wrong because slightly different from his, "E. M.," has not given a very logical reason for the criticism. Respectfully yours,

June 15, 1898. "Practical Bridge Builder."

A Visit to the Virginia Military Institute.

Sir: It is just ten years since I left my native Pennsylvania and became a citizen of the "Mother of Presidents." Although my professional duties made it possible for me to roam over nearly the entire state, and thus become intimately acquainted with the geography, yet it had never been my good fortune to visit the "Athens" of the South, the historic town of Lexington. And stranger yet to admit, the cause of my first visit to this place so revered by Virginians, was due to my being officially connected with a Sunday-school picnic excursion. The town of Lexington is situated in the heart of the famous Shenandoah Valley; and "Yankee" though I am, I must admit that, if there is any "Switzerland of America," Lexington is its center. The sublimity of its surrounding scenery is indescribable, and the exhilaration of its atmosphere! Why, even an engineer corps of the old school type could become total abstinence men and still be gay and happy there.

Lexington is the home of the Virginia Military Institute, a famous old school endowed by the state of Virginia, and is also the seat of the still older Washington and Lee University. The grounds of these schools join each other. The location is an ideal one, on the crest of a high ridge or plateau, overlooking North River. Your readers will also recall the fact that beneath the sod of Lexington rest Robert E. Lee and Stonewall Jackson, whose very names inspire the hearts of all true men.

While on my visit, it was my very good fortune to meet

Col. R. A. Marr, professor in charge of the Department of Engineering and Drawing, of the Institute.. And, by the way, I think it was a kinsman of the Colonel who was the first soldier to lay down his life for his cause in the Civil War. Col. Marr, who spent 13 years of his life on the U. S. Coast Survey, is a Virginian by birth, and it is unnecessary to state that he left nothing undone which could conduce to my comfort and pleasure. Under his guidance I visited the various departments of the institution, and I was indeed astounded with what I witnessed when I came to visit his own department. An engineer well knows that practice necessarily precedes instruction, and that institutions of learning must, as a rule, be content to follow rather than lead, and in patience await the advent of a treatise or text book before instructing their students respecting the new methods and appliances which are continually being brought forward. I was astonished, therefore, when Prof. Marr showed me plans, profiles, specifications, models, etc., of a large number of engineering works recently completed or now in progress. How gratifying all this was to me can well be understood when I recall the graduates of some other first-class institutions who have applied to me for employment; and, after examining them as to their knowledge of present-day methods of work, I found that, so far at least as railway work was concerned, their methods had long been superseded by more advanced and economical ones. Col. Marr may well be congratulated on the fact that his graduates are not filled with antediluvian methods, but can enter into the whirl of present-day practice with that sense of security which characterizes an "old timer." It is needless to say that the physical culture of the young men is as carefully looked after as is their mental training.

It is probably unnecessary to say, in conclusion, that Engineering News finds a conspicuous place in the Professor's teachings.

Theo. Low,
Supt. N. & W. Ry.

Lynchburg, Va., June 27, 1898.

The Design of Extensions to the Stony Brook Conduit, Boston, Mass.

Sir: Believing that the results of a careful investigation relative to the design and determination of discharge for various depths of a large brick channel to provide for the storm water flow from a drainage area of about 12½ square miles, which I recently had occasion to make, may be of interest to engineers engaged in that class of hydraulic work, I present them herewith.

These conclusions are presented simply as the result of a graphical analysis of 260 gagings on various channels lying within certain limits in regard to the coefficient of roughness.*

It has been the common practice in this Department to use Ganguillet and Kutter's curves for C, assuming .015 for sewers and storm water channels of any diameter and value of R.

In the year 1886 a commission composed of Messrs. Jas. B. Francis, Eliot C. Clarke and Clemens Herschel was appointed to report measures for the prevention of floods in this territory. They reported that the maximum flood discharge should be taken at 2,000 cu. ft. per sec. after the district had become well built up, and that a well built channel nearly 17 ft. in diameter with an hydraulic gradient of 1 in 900 would be required to provide for this quantity.

*These gagings may be found in Hering and Trautwine's translation of Ganguillet and Kutter's "A General Formula for the Uniform Flow of Water."

They used the expression

$$v = c\sqrt{RI},$$

assuming a value for C = 135.0 when R = 4.25. On their recommendations 4,500 ft. of channel were built in that year. At various times since the channel has been continued along the lines laid down by the commission. Up to the time of writing nearly 12,000 ft. have been built.

It becomes necessary now, for various reasons arising since 1886, to deviate from the commissioners' lines; to change the location; lower the hydraulic gradient, thereby increasing the size and with it the hydraulic mean radius, the latter to about 5 ft. These changes necessitated the adoption of a curve for C in relation to R for greater values of R for the main channel, and lesser values of R for branch channels. The influence predominating in the construction of this curve was the closest possible adherence to the opinion of the commissioners as interpreted from their report.

The investigations show that the curves of Ganguillet and Kutter, as shown on Fig. 1, are very well adapted to and present a very fair agreement with these 260 gagings. It should be borne in mind, however, that these gagings have a mean value for R of about 1; the maximum R being but about 2, with C ranging from 90 to 155.

The series of gagings on the Sudbury River and the new Croton Aqueducts were plotted as shown on Figs. 1 and 2, and these gagings were finally used as the basis for the curve under consideration as best representing this form of channel and this class of work; although, as will be noticed, there is no harmony between these curves and Ganguillet and Kutter's for value of R greater than 1.5.

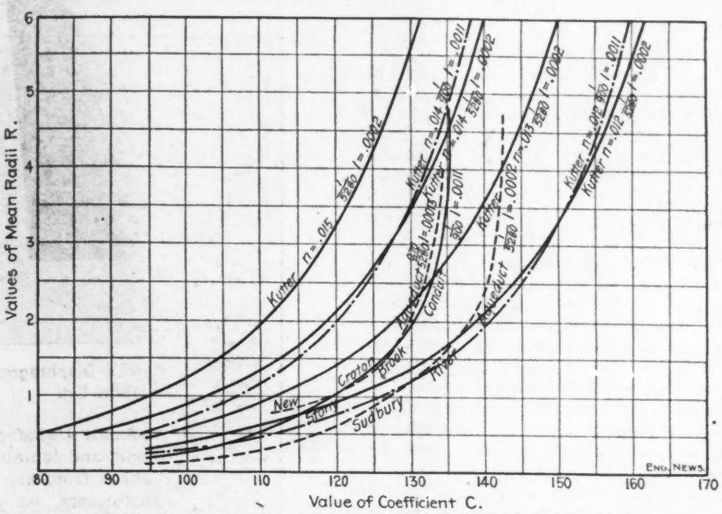
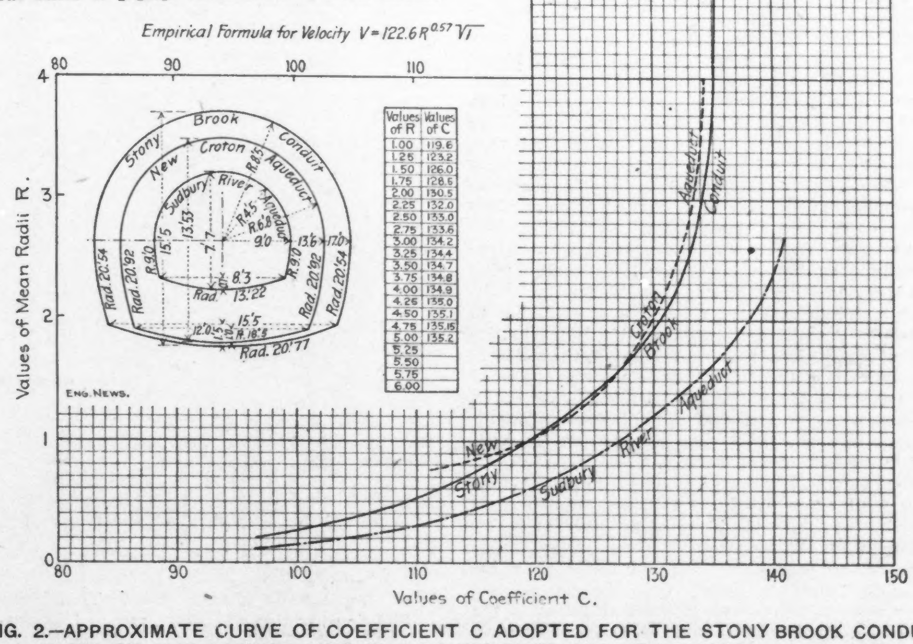


FIG. 1.—APPROXIMATE CURVE OF COEFFICIENT C ADOPTED FOR THE STONY BROOK CONDUIT, COMPARED WITH OTHER CURVES FOR C.

James Francis Desmond, Assistant Engineer.



Values of R	Values of C
1.00	119.6
1.25	123.2
1.50	126.0
1.75	128.5
2.00	130.5
2.25	132.0
2.50	133.0
2.75	133.6
3.00	134.2
3.25	134.4
3.50	134.7
3.75	134.8
4.00	134.9
4.25	135.0
4.50	135.1
4.75	135.15
5.00	135.2
5.25	
5.50	
5.75	
6.00	

FIG. 2.—APPROXIMATE CURVE OF COEFFICIENT C ADOPTED FOR THE STONY BROOK CONDUIT, BASED ON THE GAGINGS OF THE SUDBURY RIVER AND NEW CROTON AQUEDUCTS.

The empirical formula

$$v = 122.6\ R^{0.57}\sqrt{I}$$

deduced from this curve, I believe to be at least worthy of consideration in calculating the discharge of storm water channels of this form and class of work—that is, for good, clean brick, well made joints and easy curves for values of R from 1 to 5, with I varying from 0.001 to 0.0002. Perhaps the range given to I may be considered by engineers as rather a wide one, but I have reason to believe, from a close study of the matter, that the variations in C due to this are slight.

In the absence of more material on which to build I leave to the judgment of the engineer the real value of this curve.

Very respectfully,
James Francis Desmond,
Assistant Engineer, Sewer Department.

28 Court Square, Boston, Mass., June 1, 1898.

The New York Fireproofing Tests.

Sir: An inquiry received this morning from a customer of ours leads me to address you for some information, thinking that as a public newspaper you might be able to secure answer to certain inquiries that we cannot.

This customer of ours writes to know where he can secure printed reports of the fireproofing tests made by the Building Department on our form of construction, together with others made about the same time.

You doubtless will remember that during the fall of 1896 and the spring of 1897, fireproofing tests were going on very frequently. There occurred, within twelve months, not less than 20 in all, at an average cost to each of the individuals or concerns, whose materials were tested,, of not less than $1,000, to say nothing about a still vaster sum of official red tape that enveloped the whole transaction.

It was a public boast that these tests were to be the most famous in the history of building material. But alas! the $20,000 and miles of red tape, have apparently all gone for naught. Each of the concerns, whose material was tested, received an official document entitled "Result of the Test." They were written, doubtless, weeks after the tests themselves. This I say, for the reason that the reports were very cold and deep. The reports were merely a mass of figures, indicating temperatures, strains, etc., with no conclusions drawn or other statements made which would in any wise guide the inquiring, interested public.

The inquiry I desire to make of you is: "What benefit was the expenditure of all this money to the public, or for that matter to the people who expended it?" Why were not the reports of these official tests published? We are told that the building department to-day refuses to acknowledge the existence of any such tests. The engineers of the department will not even refer to the records on file, to establish the slightest fact connected with any part of the test.

The situation savors very strongly of "a Senegambian in

the lumber heap." Will the vigorous inquiry department of the Engineering News please find him, and much oblige one of the contributors to the $20,000 expense fund?

Very truly yours,

A Cash Sufferer.

New York, June 21, 1898.

(We presume our correspondent can answer the questions which he propounds quite as well as we. As some of our readers may not be so well informed, however, we will endeavor to answer his questions. In the first place, the tests of fireproof

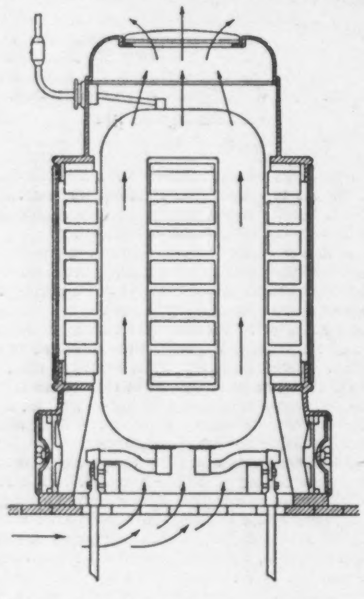


Fig. 1.—Section of Air Blast Transformer Showing Direction of Air Current.

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

floors to which our correspondent refers were in many respects well planned, and did give a great amount of valuable information to the profession as to the strength and fire-resisting powers of the styles of fireproof floor construction. The reports of these tests, which were published in Engineering News, give fairly complete records of their results. It is certainly unfortunate that an impartial and concise report of all the tests was not published by the city authorities at their close, and we can hardly blame those who contributed to this "$20,000 expense fund" for feeling very sore at its absence. The reason why no such report was made, to the best of our knowledge, is first, that such reports as were presented were so long and detailed that their publication would have been of little benefit to any one, and second, that lack of harmony between the Superintendent of the Building Department then in office and the city financial authorities prevented any appropriation of funds for this purpose.

As to the reason why the present administration ignores the results of the tests made during the last administration, we thought best to let the administration speak for itself, and with that in view we submitted a proof of this letter to Superintendent Brady, of the New York Building Department with an invitation to present a reply for publication in connection with the above letter, in accordance with our usual rule when communications sent for publication contain matter criticising the acts of any person.

That official, however, has made no reply whatever, and after waiting ten days we are compelled to conclude that he has no reply to make. Comment on the autocratic methods in the Building Department which our correspondent's inquiry discloses is needless.

We deem it well to call especial attention to the things set forth in the above letter, because other city authorities are apt to look to New York, the largest city in the country, for guidance in the matters of building laws and building inspection. If they do so now they should do so with the full understanding that not a few things in the New York law and its administration are the result of influence and political pulls, without regard to the real value of materials and methods from an engineering point of view.—Ed.)

METHODS OF COOLING TRANSFORMERS OF LARGE SIZE.

The transformer, as its name implies, is a device for changing electric energy furnished under one set of conditions to the same kind of energy for use under a different set of conditions. This transformation is accomplished by making use of induction and the magnetic properties of iron, but with a loss which is greater or less according to the character of the material used, its amount and its distribution. The loss always takes the form of heat, which must be dissipated as fast as generated or it will gradually accumulate in the transformer and raise its temperature to a point where serious injury will be done to the insulation. The removal of heat from a large transformer is really the element on which its capacity chiefly depends, and provision for it is therefore among the most important elements in its design. Small transformers have so large a surface in proportion to their bulk that they are sufficiently cooled by radiation and the natural circulation of air about them. As the size increases, however, the ratio of the volume to surface exposed also increases, and artificial means of cooling become necessary for both economy and safety. If these are not employed the designer must depart from the most compact and most economical proportions and sacrifice material and strength to obtain sufficient external surface to radiate the heat. It is usually necessary for mechanical protection to enclose the transformer, and this materially interferes with the cooling by natural radiation.

A practice in extensive use with transformers of moderate size is filling the case with oil, which acts as both an insulating and a cooling medium and considerably increases the capacity. Various designs have been adopted in which provision is made for the circulation of the oil through the interior of the transformer. If ducts passing entirely through the body of the winding are provided, however, they must be narrow or the size and cost of the transformer will be excessive and the efficiency low, not to mention the greater space required. On the other hand, with narrow ducts oil is not a reliable cooling medium. Its circulation under the best conditions is sluggish, while the ducts tend to close gradually from the swelling of the insulating wrapping on the coils and the collection in the ducts of a deposit de-

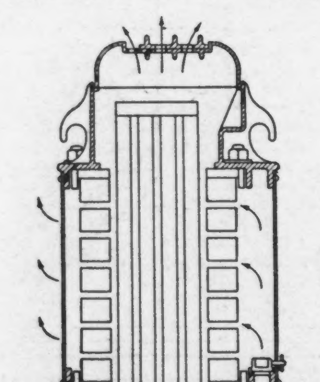


Fig. 2.—Section of Air Blast Transformer Showing Position of Coils, Core, and Casing and Direction of Air Currents.

rived from the slow solution of the various liquid insulations employed when winding the coils.

To overcome these drawbacks a new design was introduced in which the height of the laminated core is small compared with the external dimensions of the punchings. A large proportion of the copper is external to the core, and the exposed ends are so spread apart as to give wide openings between the coils for the access of the oil. This design insures a low temperature in the exposed part and even a moderate average temperature (measured by increase in resistance), but the central portion often becomes dangerously hot without giving any direct evidence of the fact; and it is of course no less serious to have a high temperature in any part of the transformer than to have the entire winding at an unsafe temperature.

In large transformers the use of oil is undesirable for reasons other than its poor efficiency

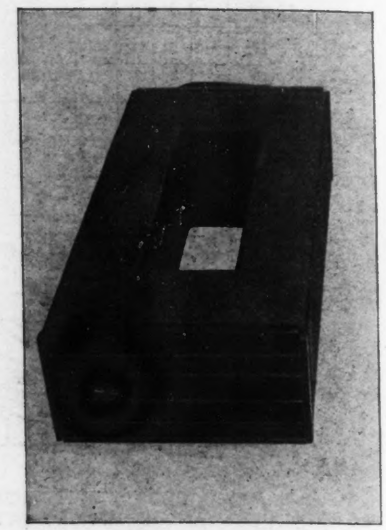


Fig. 3.—Coils Assembled with Diaphragms in Place and Insulation On.

as a cooling medium. Small transformers are usually installed out of doors and contain so small a quantity of oil that danger from fire is almost impossible. Large transformers, on the other hand, form ordinarily part of extensive plants, many units being banked together within a single building, and the chances of fire would be greatly increased by the use of oil. Moreover, it is almost impossible to make large transformer cases oil tight. For these reasons satisfactory results are not obtainable with large transformers if dependence is placed entirely on external surface heat regulation or on oil as a cooling medium.

The General Electric Co. has adopted the air cooling system for its large transformers. In this type of transformer currents of air are made to pass through small ducts and channels in the interior of the transformers and take up the heat from the large amount of surface thus exposed. Two methods are employed as standard practice by the General Electric Co. in the construction of its large transformers. In the "Air Blast" type, Figs. 1, 2 and 5, the current of cool air is forced upward through the core and windings. In the "Natural Draft" type the coils and core are so proportioned and placed that large surfaces are exposed and the temperature kept within safe limits by the natural circulation of the air. In the "Air Blast" type the cooling current of air is obtained from a motor-driven blower and is forced from below through separate paths at right angles to each other vertically through the windings and horizontally through the core, Figs. 1 and 2. The admission of air is controlled by shutters at the top and at the sides of the transformer. The power used by the blower seldom exceeds ¼ of 1% of the total capacity of the transformer, and in most cases is much less, frequently not more than 1-10%. It is considerably less than that which would be required to pump oil through an oil-cooled transformer of the same capacity.

The air blast type is designed for continuous operation, large output and high potential. In it the windings are subdivided into numerous independent coils, each separately and heavily insulated. With such subdivision the voltage generated in a single section is low, even in transformers wound for a voltage of 15,000 to 20,000 volts, and the numerous air ducts between all the coils which this subdivision allows in addition to the spaces in the iron lamenation of the core, Fig. 4, limits the rise in temperature to a few degrees. The coils are wound with flat copper conductors cemented together by an insulating compound before the exterior insulation is applied. The use of rigid coils is important in large transformers since the magnetic force tending to move the conductor is great, and vibration, abrading

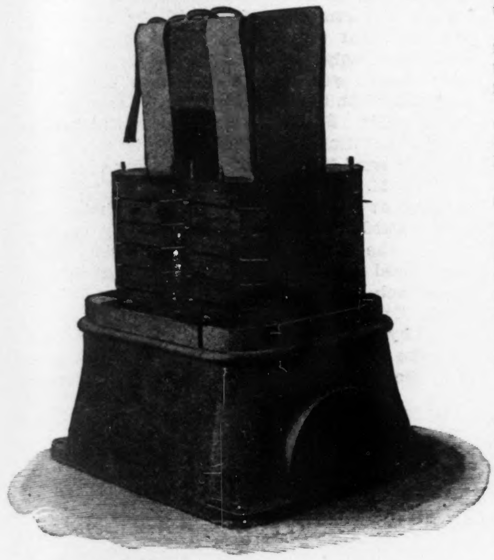


Fig. 4.—Building Up the Core, Showing Assembled Coils in Place and Core Partially Built Up.

the insulation, might be set up. The primary and secondary coils are assembled in small intermixed groups with air spaces between the coils, and between every adjacent primary and secondary section are solid insulating diaphragms which completely encase the primary winding except at either end of the core, necessarily left open to allow the air to circulate freely. At the end, however, the diaphragms project far beyond the coils, so that a surface insulation of great extent is provided between the primary and secondary. An additional insulation casing is placed around the entire structure of assembled primary, Fig. 3, and secondary coils and separates the whole winding from the iron punchings assembled within and around them. The method of insulation employed assures a factor of safety of at least 3, and the insulation test between the high potential windings and the core is made at a voltage equal to twice the rated potential.

Calculating the temperature of the interior of the air blast transformer by the rise in resistance of its windings, the rise in temperature is guaranteed not to exceed 40° C. above that of the surrounding air.

Air blast transformers are used on 15,000 volts potential or less, and are constructed for higher potential when necessary. Over 100,000 HP. in these air blast transformers have been installed, and no record yet exists of a burn-out due to heating or overload.

ANNUAL MEETING OF THE ASSOCIATION OF GERMAN PORTLAND CEMENT MANUFACTURERS.

Abstracted by S. B. Newberry, Assoc. M. Am. Soc. C. E.,* from the Official Report.

The annual meeting of the Association of German Portland Cement Manufacturers took place in the audience room of the Architects Institute, Berlin, Feb. 23 and 24, 1898. The membership of the association includes representatives of 83 factories, having a total production in 1897 of 17,150,000 barrels of Portland cement. This production is divided amoung various countries, as follows:

Germany	66	factories,	product	14,950,000	barrels.
Austria	10	"	"	1,150,000	"
Other countries	7	"	"	1,050,000	"
Total	83	"	"	17,150,000	"

The United States is represented in the association by one factory only, the Alamo Cement Co., of San Antonio, Texas.

Dr. Prussing reported on the unfair competition of the "Natural Portland Cements" of Belgium against the true artificial Portland cement of Germany. These Belgian cements are chiefly made by the direct burning of a limestone of approximately the composition of a correct cement mixture. The variations in the proportions of lime and clay present in the rock, however, cause great fluctuations in the quality of the product, and much of the Belgian cement is greatly inferior to true Portland. Most Belgian manufacturers sell their product under foreign labels as "Portland cement of highest quality," and in many cases well-known German labels are purposely counterfeited.

At a meeting of English and German cement manufacturers, held in Cologne in July, 1897, it was resolved to take the following steps to meet this fraudulent competition:

1. Samples of Belgian natural cement are to be purchased in open market and tested at the Royal Testing Station at Charlottenburg, and by competent experts in England.
2. An attempt is to be made to secure from the Belgian government an official definition of Portland cement.
3. A pamphlet is to be published, showing the untrustworthiness of the so-called "Natural Portland cements," and stating the names of the Belgian factories which produce a genuine and reliable article. This pamphlet is to appear in German, English, French and other languages, and is to be circulated as widely as possible in all countries.

Report of the Committee on the Action of Sea-Water on Hydraulic Cements.

R. Dykerhoff stated that the committee had decided to extend their observations over a period of 10 years. A part of the test-pieces of the series of 1896, exposed to the action of sea-water at the Island of Sylt, were destroyed or damaged by heavy storms. Only the rich cement mortars, especially those of Portland cement and sand, 1 to 1, had perfectly resisted the mechanical and chemical action of the sea. Poorer mixtures, and especially the trass-lime mortars, were more or less attacked.

At the meeting of the committee, held in February, 1897, it was resolved to limit the experiments, for the present, to the determination of the effect of the addition of trass on the resistance of Portland cement mortar to the action of sea-water. Trass is a volcanic scoria found near the Rhue, and similar to the Pozzuolana of Italy in its power of conferring hydraulic properties upon slaked lime. According to Dr. Michaelis, trass has the power of neutralizing the possible injurious effect of the high proportions of lime contained in Portland cement, and thus increasing its power of resistance to the chemical action of sea-water. This view is opposed by many of the leading authorities on cement, who have shown that dense Portland cement concretes have given excellent results over long periods of years when exposed to the action of the sea.

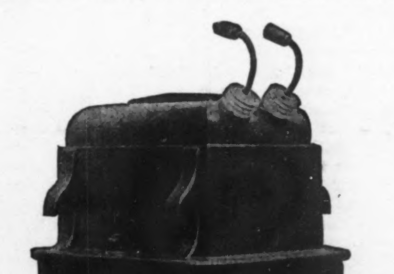


Fig. 5.—Transformer Completed with Cap and Casing in Place.

The committee decided to make a long series of tests of the effect of trass, using

1. A cement high in lime and low in alumina.
2. A cement high in lime and high in alumina.
3. A cement low in lime and high in alumina.

These are to be tested with various proportions of sand, with and without the addition of trass. The test pieces are to be placed in sea-water in such a manner as to be protected from the direct force of the waves, but exposed to the ebb and flow of the tide. Tests are to be made at 7, 28 and 90 days, 1 year, and longer periods.

Referring to the possibility of chemical action between the silica of trass, or other forms of silica, and the lime set free in hardening of cement, Dykerhoff referred to an interesting paper lately published by Lunge* on the action of various forms of silica on caustic alkalies and alkaline carbonates. Lunge found that quartz, a form of silica generally considered entirely insoluble in alkalies, may be rendered considerably soluble in caustic alkalies or even alkaline carbonates by extremely fine pulverization (elutriation). It might therefore appear probable that very fine quartz sand may enter into combination with the lime set free in the hardening of cement. To determine whether this is the case, Dykerhoff made a careful series of tests with mixtures of cement and natural sand, 1 to 2 and 1 to 4, in which one-half the cement was replaced by

1. Sand passing a sieve of 28 meshes to the inch.
2. Ground sand passing a 75-mesh and retained on a 177-mesh sieve.
3. Ground and passing a 177-mesh sieve.

Complete tables showing the results obtained are given in the report, but would occupy more space than can be allowed in this abstract. It was found that the replacement of one-half the cement by fine sand lowered the strengths materially, but that the finer the sand was ground the less the strength was reduced. From this it might appear that some chemical action between the fine sand and the cement had taken place. The comparative weight of the briquettes showed, however, that the decrease in strength was nearly proportional to the density, and that the higher results obtained with the finely ground sand are probably due to more perfect filling of the voids.

In order to determine whether a slight chemical action might not have taken place, the effect of finely ground sand and finely ground marble were compared. Both sand and marble were ground to pass a 177-mesh sieve. The results were as follows:

Tensile Strength in Pounds Per Square Inch.

	400 cement, 1,600 normal sand.	400 cement, 200 grnd. sand, 1,600 normal sand.	400 cement, 200 grnd. marble, 1,600 normal sand.
7 days	221	256	255
28 days	249	307	307
90 days	309	366	372
Weight of 5 briquettes	786 grams	825 grams	820 grams

From the above table it will be seen that the two finely pulverized materials have increased the strength equally. Since the carbonate of lime of the mortar is chemically entirely inactive, it is evident that the finely divided sand has exerted no chemical action. Whether a slight chemical effect may take place at long periods is of no consequence from a practical point of view. The use of finely ground sand to increase the strength of poor mixtures of cement and coarse sand will hardly be applied in practice, since equal, or even higher strengths can be obtained by the use of natural sands of graded fineness. This is shown by the following comparative tests at 90 days:

	Tensile strength.	Weight of 5 briquettes.
400 cement, 1,600 normal sand	309	786 grams.
400 cement, 200 ground sand, 1,600 normal sand	366	825 "
400 cement, 1,800 Rhine sand	362	805 "
400 cement, 1,600 Rhine sand	426	827 "

This table shows how the density and strength of mortars are influenced by the character of the sand employed. In marine constructions the density of the concrete, as well as its strength, is of great importance. It is therefore especially necessary, in this class of work, to select sands containing the smallest possible proportion of voids.

Calcium Hydroxide, Ca (O H_2), in Hardened Portland Cement.—Professor Schuliatschenko presented an account of the investigations of Ljamin, a Russian engineer, on this subject. Le Chatelier, in 1885, advanced the view that the hardening of Portland cement consists in the conversion of the tri-calcium silicate, 3 Ca O, SiO_2 under the influence of water, into a crystalline mass of hydrated mono-silicate and calcium hydroxide. This view was founded on a microscopic study of the process of hardening. Ljamin finds that it is possible to separate the hydroxide from the other constituents of hardened cements by use of a mixture of methylene iodide and benzol, of a specific gravity of 2.3. In this liquid the hydroxide (sp. grav. 2.1) rises to the surface, and may be quantitatively determined. He finds that the proportion of hydroxide in hardened cement increases rapidly during the earlier stages of the hardening, and reaches 31 to 33% at 90 days. After this time the increase is slight.

This result was confirmed by another method, based upon the different temperatures at which the hydrated silicates and the hydroxides give up their combined water. According to Ljamin, the hydrated silicates are decom-

*Manager Sandusky Portland Cement Co., Sandusky, O.

*Thonindustrie Zeitung, 1898, p. 800.

posed at 160° C., while a temperature of 480° C. is required to decompose the hydroxide. The results obtained by the two methods agree very closely. These observations, and also the remarkable parallelism which is shown in the progressive gain in strength of cements and the percentage of calcium hydroxide formed, served as an important confirmation of the Le Chatelier hypothesis.

Roman (natural hydraulic) cement, on the other hand, showed after 60 days hardening only 2% of hydroxide. It is evident, therefore, that the reactions which take place in the hardening of Roman and of Portland cement are radically different.

For the purpose of studying the effect of sea-water on Portland cement, Ljamin analyzed samples from well-preserved blocks of concrete which for 30 years had been exposed to the water of the Black Sea at Potihafen. These blocks showed a very hard crust, about one-eighth of an inch thick, on their surface. This crust contained 20% of carbon dioxide. One-fourth inch from the surface the proportion of carbon dioxide was only 5%, and at a depth of 1 in. only traces were found. Free calcium hydroxide was not found in the outer crust, but in the interior of the blocks this substance was present to the amount of 33%. It is evident, therefore, that the presence of large amounts of free hydroxide in bardened cement is no cause of injury by sea-water.

Report of the Committee on Tests for Constant Volume of Portland Cement.—A series of experiments on tests of constant volume was begun early in 1896. Ten Portland cements which were thought to be imperfect in the matter of constant volume were assigned to the various members of the committee to be independently tested. In addition, a number of medallions, 12 ins. in diameter and 1¼ ins. thick, and rosettes 10 ins. in diameter and 2 ins. thick, were prepared with the same cements. These were made with a surface of one of cement to one of sand and filled in with mixtures of cement one, sand two, and cement one, sand four. The medallions and rosettes so prepared were kept damp for three days in a closed room and then exposed to the weather.

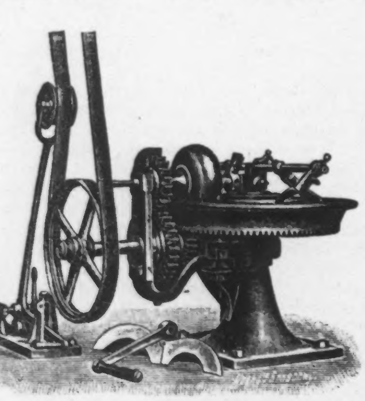
The ordinary cold pat tests of all the ten cements were fully satisfactory. Accelerated tests at higher temperatures gave varying results. Most of the samples stood the oven test at 100° C., but the majority failed in the Michaelis and Tetmajer boiling tests and the Maclay hot water test. No cement passed all the accelerated tests satisfactorily.

Observations of the medallions and rosettes after exposure of 1½ years to the weather showed that all were hard, well preserved and faultless. It is generally agreed that the durability of artificial stone prepared from a given Portland cement is the best evidence of constancy of volume. The committee therefore concluded that accelerated tests are of no value in determining the durability of cements in practical use.

Report of the Committee on the Steinbruck Mortar-Mixer for Cement Testing.

It is well known that in the ordinary methods of mixing cement with sand and water for testing purposes the method followed and the personal equation of the operator are of great influence on the results. A widespread desire exists, therefore, for a more uniform mixing process. The apparatus which the committee consider the mixing-machine of the future is shown in the accompanying illustration.

The capacity of the apparatus is about 4 lbs. of mixture of cement 1, sand 3. The roller and plows may be



The Steinbruck Mixer for Preparing Mortar for Cement Test Briquettes.

Made by the Chemisches Laboratorium fur Thonindustrie, Berlin, Germany.

easily and quickly removed for the purpose of emptying and cleaning the pan. Careful experiments have shown that no pulverization of the sand takes place during the operation. The gearing is so designed that 50 turns of the handle give 8 revolutions of the pan.

Tests of a slow-setting Portland cement gave the results shown in the following table. Each figure represents the average of 10 test-pieces:

	Tensile strength, lbs. per sq in. Cement 1, sand 3. 7 days.	28 days.	90 days.
Hand mixing	278	349	438
Machine mixing—			
6 pan revolutions	266	356	434
8 " "	283	362	455
10 " "	273	361	468
15 " "	294	371	480
20 " "	302	403	452
30 " "	295	390	421
40 " "	319	386	471
50 " "	339	382	482
70 " "	330	395	519
100 " "	338	403	568

This table shows that about 8 revolutions of the pan are required to give the same results as those obtained by hand-mixing. The strength continues to increase greatly with increasing number of revolutions, and does not appear to have reached a maximum at 100 turns. It is to be expected that at a certain point the strength will begin to decrease in consequence of incipient setting of the mortar. Careful experiments to determine this point are now in progress, and tests thus far completed seem to indicate that a maximum is reached at about 150 revolutions.

The machine is arranged to be driven by hand or by power. When turned by hand it is found that a convenient speed is about 8 pan revolutions per minute. The apparatus in its improved form is now offered for sale by the Chemisches Laboratorium fur Thonindustrie, Berlin.

On the Action of Water Containing Carbonic Acid on Portland Cement.—In the report of the 1897 meeting a number of cases of corrosion of reservoir linings by carbonated water were mentioned. At the 1898 meeting Schiffner gave an account of an interesting series of experiments on this subject. Briquettes of the following mixtures were prepared:

Trass, 1; lime, 1; normal sand, 1.

Portland cement, 1; ground trass, 1; normal sand, 2.

Portland cement, 1; ground sand, 1; normal sand, 2.

The "ground trass" and "ground sand" had been pulverized to such fineness as to pass a sieve of 177 meshes to the linear inch.

These briquettes were kept in moist air one day, then in water in the laboratory three to six weeks. One-half of them were then placed in baskets and suspended in the water of the water-works spring at Bonn on the Rhine, while the remaining half remained in water in the laboratory. After 16 to 18 months the briquettes were inspected.

Those kept in the laboratory were found to be completely intact and well hardened, while those exposed to the action of the spring water showed more or less decrease in volume and strength. The reduction in volume was as follows:

Trass and lime	13.76%
Cement and ground trass	8.90%
Cement and ground sand	7.78%

The addition of trass appears, therefore, to have given no better results than that of fine sand.

Later tests with a mixture of Portland cement 1, normal sand 1, showed after three months' action of the spring water a loss in volume of only 1.77%.

Immersion of the briquettes in solutions of fluorides proved to diminish the corrosive effect of the water. The best result was obtained with lead fluoride. Briquettes of Portland cement with 3 parts normal sand were prepared, kept in moist air one day, then three times immersed, for 24 hours each, in a solution of lead fluoride, and dried. These were then placed in the spring water, and after 9½ months showed a loss in volume of only 0.06%.

The water supply at Bonn is obtained from a spring, and shows the following composition, in grams per liter (parts in 1,000):

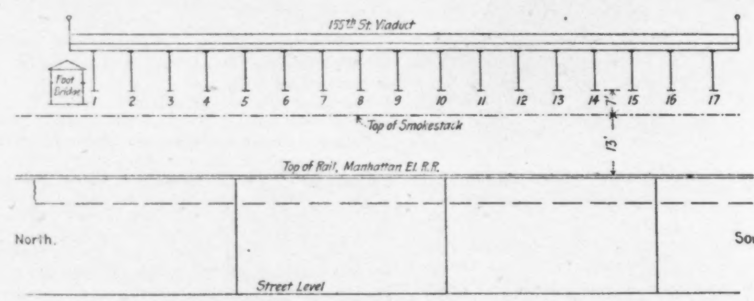
Sodium chloride	0.1246
" sulphate	0.0689
" bicarbonate	0.0477
Calcium carbonate	0.2400
Magnesium "	0.0605
Silica, iron oxide and alumina	0.0165
Organic matter	0.0043
Carbon dioxide, dissolved gas	0.3985

The water of the river Rhine at Bonn shows only ⅛ as much carbon dioxide and 1-14 as much sodium chloride as that contained in the spring-water.

TESTS OF VARIOUS PAINTS ON THE 155TH ST. VIADUCT, NEW YORK CITY.

In our issue of Sept. 23, 1897, the method of cleaning the iron work of this viaduct, as a preliminary to repainting the structure, was fully described. The cleaning was done by the Tilghman sand-blast process, the mixed air and sand striking the paint with a velocity of 250 to 300 ft. per second. Mr. M. E. Evans, the engineer in charge for the Department of Public Works, reported at the time that the surface of iron thus cleaned was exceedingly susceptible to rust, and if not at once covered with paint a few hours' exposure to ordinarily humid air resulted in a thin coating of red oxide. For this reason the work of cleaning and painting was carried on alternately each day, the sand-blast gang commencing operations at 6 A. M. and stopping at 3 P. M., when the painters at once began applying a priming coat and worked until 6 P. M., completely covering all of the surface cleaned that day. The paint used was supplied by seventeen different firms, each section being painted with a different paint. The paints were applied by workmen employed by the city.

As the painted surface is exposed to the gases from the locomotives of the Manhattan Elevated R. R., which pass directly under the structure, and as all the paints were applied to a clean iron surface, the comparative test is probably the fairest and most complete that has even been made of paints for the protection of iron work exposed to locomotive gases.



CROSS-SECTION OF 155TH ST. VIADUCT. SHOWING POSITION WITH RELATION TO MANHATTAN ELEVATED R. R.

A report upon the condition of these various paints has recently been made by Mr. Henry B. Seaman, M. Am. Soc. C. E., and we present it in full herewith as follows.

On April 12th, 1898, the writer made an examination of the different paints on that span of the 155th St. Viaduct which is directly over the tracks of the Manhattan Elevated Railroad at 8th Ave., and submits the following report:

This part of the bridge spans three tracks and two platforms, at the 155th St. station of the Elevated Railroad, and is composed of 17 lattice girders carrying floor beams upon which are riveted buckle plates, which in turn carry the roadway of the 155th St. Viaduct. These 17 girders are of 69 ft. span and 9 ft. in depth, being spaced 9 to 10 ft. apart, and having the bottom flanges about 7 ft. above the tops of the locomotive stacks. For convenient reference in this report, these girders are numbered from 1 to 17 consecutively, beginning at the north end.

A foot-bridge, located just north of girder No 1 also crosses above the tracks. The floor of this bridge is about 4 ft. below the bottom flange of girder No. 1 and about 3 ft. away from it in the clear. The 155th St. station being the terminus of the railway, the two outside tracks are in constant use by arriving and departing trains, while the middle track is used mainly by switching locomotives.

During the greater part of the day, trains arrive three minutes apart, alternating between the easterly and westerly tracks. The locomotives of the north-bound trains on the easterly track stop with the stack directly under girder No. 5, and remain about 20 seconds before hauling out. Incoming trains on the westerly track do not stop until the locomotive has passed north beyond the foot-bridge. All trains approach the station with steam shut off, except that used for brakes. It will thus be seen that the only girders which constantly receive the direct blast of the engine are girders No. 1 to 5 inclusive, the remaining girders receiving blasts only upon the occasional switching of engines, and in making up trains. In all other cases the girders are exposed alike to only such gases as the locomotives emit while the steam is shut off.

In making the examination, a careful general scrutiny was given to each girder from the platform below, and each was given a percentage mark, denoting the amount of surface free from rust. These percentages were then carefully compared and reviewed so that they might correctly represent the comparative condition of each girder. When these tests were completed, a thorough inspection was made by climbing through the structure and the character of rust was denoted for each girder. After completing the examination and recording the results, the kinds of paint used for each girder, with the number of coats and comparative rapidity of drying, were obtained from Mr. M. E. Evans, C. E., under whose direct supervision the girders were cleaned and the various paints were applied. The accompanying table gives the summary of the results:

Results of Tests of Paints on 155th St. Viaduct, New York City.

No. of girder.	Kind of paint.	Number of coats.	Rate of drying.	% free from rust.*
1	Lead, graphite and lucol oil.	3	Medium.	97[1]
2	Graphite and linseed oil.	2	Slow.	80[2]
3	Red lead, "Antoxide F," "Antoxide D."	2	Fast.	25[3]
4	Graphite.	2	Slow.	75[4]
5	"Nobrac."	3	Medium.	99[5]
6	"Carbon black."	2	Slow.	85[4]
7	"Durable metal coating."	2	Slow.	75[4]
8	"Black manganese iron."	2	Fast.	30[6]
9	"Carbonizing coating."	2	Slow.	80[4]
10	"Mineral rubber."	4	Fast.	78[7]
11	"Black."	2	Medium.	58[8]
12	Carbon.	2	Medium.	92[4]
13	Graphite.	2	Medium.	67[4]
14	Graphite.	2	Slow.	70[4]
15	Asphalt.	2	Very slow.	65[9]
16	"Ruberine."	2	Medium.	58[10]
17	"Black Diamond."	2	Medium.	70[11]

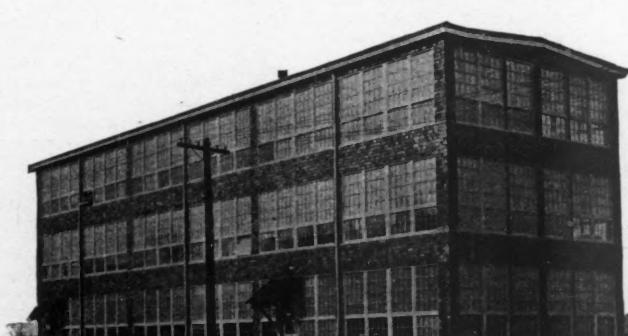
*Percentage of surface free from rust, April 12, 1898.
[1]Paint crumbling in places, as though rotten; very little rust.
[2]In fair condition, but discolored; rust coming through.
[3]Very badly rusted. [4]Rust not deep.
[5]Slight rust on top flange of one panel; rest of girder clear.
[6]Rust very deep; buckle plates bad.
[7]Area of rust spots small; rust very deep.
[8]Rust bad and deep.
[9]Deeply rusted; buckle plates still good.
[10]Rust deep and angry; buckle plates mildewed.
[11]Small pimples of rust, as though formed under paint.

It will be noticed, both by the percentage of clear surface and the character of rust on close examination, that girder No. 5 is preserved better than any of the set. When it is also considered that the priming coat of this girder was the one first applied, that it has been the most severely exposed to sulphur fumes, and that a portion of the priming coat was applied with the humidity averaging 96% for the day (where 100% is absolute saturation), the comparative condition in favor of girder No. 5 is very marked.

Respectfully,
Henry B. Seaman.
40 Wall St., New York city, May 24, 1898.

A FACTORY BUILDING OF STEEL AND GLASS.

The accompanying illustration is a view of a machine shop designed and built by the Berlin Iron Bridge Co., of East Berlin, Conn., for the Veeder Mfg. Co., of Hartford, Conn., the makers of the well-known Veeder cyclometer for bicycles. In the design of the building one of the principal ideas was that it should have an abundance of light on every square foot of floor space, so that it could all be available for carrying out the very fine operations required in the manufacture of cyclometers. The framework of the building is entirely of steel, the greater portion of the construction being steel and glass. It is three stories in height, 30 ft. in width, and 110 ft. in length, the three floors giving nearly 10,000 sq. ft. of floor surface. The glass sides of the building are arranged in sections, and every other panel swings on center pivots, so that they can be easily opened and closed. In warm weather, by opening enough of the panels to allow plenty of air to circulate, the interior may be kept as cool as that of any other kind of building under the same conditions of weather. The glass used in the sides is roughened or corrugated plate glass about 1/8-in. thick.



FACTORY OF THE VEEDER MFG. CO., HARTFORD, CONN.
Built by the Berlin Iron Bridge Co., East Berlin, Conn.

The floors are carried by girders spanning the entire width between the sides of the building, so that the floor space is entirely unobstructed by columns. The roof trusses are of sufficient strength to carry shafting, pulleys, hangers, etc., in addition to the roof load.

The heating of the building is done by the blower system, hot air being forced into the interior from an adjoining boiler-room. The air ducts are located in and made part of the supporting columns of the building. This feature was designed by Mr. C. H. Veeder, president of the Veeder Mfg. Co., and adopted by the Berlin Iron Bridge Co. in its design. The blower system may also be used for blowing cool air into the building in the summer.

An interesting question in relation to this building, on which we trust the Berlin Iron Bridge Co. may give us some information next year, is what will it cost to heat the building in cold weather? It is generally considered by heating and ventilating engineers that the emission of heat from glass surfaces is much greater than that from ordinary walls and roofs of buildings. If this is true, the heating of this building would be somewhat expensive. At any rate, the building offers a good chance to get some valuable data on the subject. We would suggest that an approximate idea of the cost of heating, independent of the power needed to circulate the warm air, could be obtained by measuring the drip from the air heating coils by means of a water meter. A reading of the meter taken every night and morning, together with the records of registering thermometers, one recording the temperature inside and the other that outside of the building, would furnish a set of data that should be of great value to heating and ventilating engineers and to mill architects.

A NOVEL FIXED ANCHOR CONSTRUCTION FOR JETTIES, BUOYS AND LIGHT SHIPS.

We illustrate herewith a rather novel, and, according to all reports, a very efficient system of anchors employed in the construction of a small jetty built at Atlantic City, N. J., in 1897, to break the force of the waves, which were gradually tearing away the bathing beach and rendering it unfit for use. This jetty extends out from the shore a distance of 200 ft., and is built of cedar brush fascines, laid cob-house fashion, with the interstices filled with stone and anchored down to the sand bottom. Fig. 1 shows the arrangement of the fascines and anchor system in this jetty, and Fig. 2 shows the construction of the anchors proper in more detail. These anchors have been patented, the patent having relation to

anchors for securing jetties, buoys, piers, dykes, lightships, and like constructions which require permanent fixed anchors for holding them in position, and consists in the devices hereinafter described constructed to accomplish the ready sinking of the anchor and the retaining its desired position when sunk to the proper depth.

The inventor is Mrs. Gertrude Stuart Baillie, of Philadelphia, Pa., and the use and sale of the system is controlled by the Sea Coast Jetty Co., 1420 Chestnut St., Philadelphia, Pa.

The construction of the Atlantic City jetty is shown very clearly by Fig. 1. The fascines were of cedar brush, bound by wire in the usual manner, and were 1 ft. in diameter. The bottom fascines were laid parallel to the longitudinal axis of the jetty 1 ft. apart in the clear. On the top of these came a layer of fascines laid at right angles to the first and 1 ft. apart, and finally another layer of longitudinal fascines laid like the first. The interstices between the three layers of fascines were filled with stone, and the whole was anchored down by a system of 5/8-in. wire cables

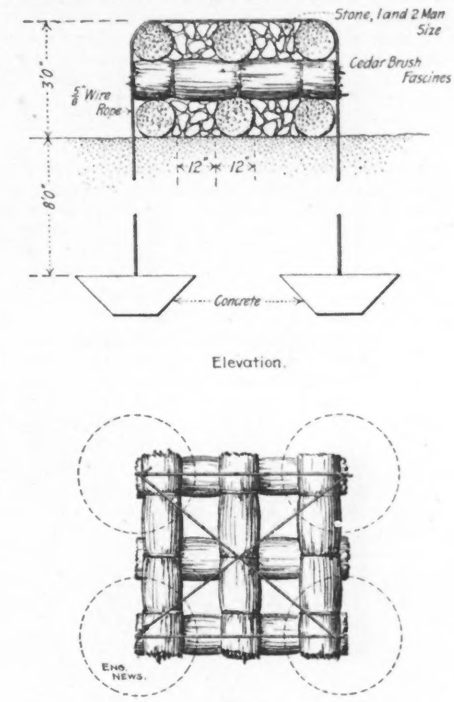


Fig. 1.—Sketch Plan and Section Showing Construction and Anchorage of Jetty Breakwater at Atlantic City, N. J.

attached to the special concrete anchors. The cost of the jetty was less than $10 per lineal foot.

Turning now to the enlarged drawings of the anchor, A represents the main body of the anchor, which is made preferably of a wedge or cone-shape to allow it more readily to bury itself as the sand or earth is loosened or displaced from beneath it. In the upper portion of the body A is

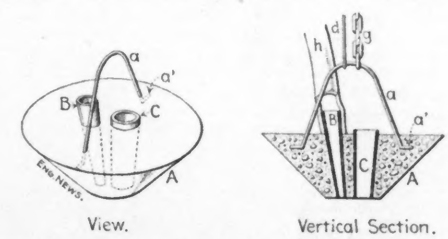


Fig. 2.—Special Concrete Anchor for Atlantic City Breakwater, Showing Attachments for Water Jet Used in Sinking.

provided a staple a, secured from displacement by the hooked ends a' or by other suitable means. Perpendicularly through the anchor near the center is a pipe B, the upper end of which protrudes above the top of the anchor and is adapted to receive the end of a flexible water-supply pipe secured thereto by any desirable means, as by being stretched over the mouth of the pipe B. When the anchor is settled to its desired position, the flexible hose is pulled off or cut off at the water's edge, dropped, and thus disposed of. A waste-escape pipe C is also provided perpendicularly through the anchor adjacent to the water-supply pipe B.

In operation the anchor, fitted with a lowering cord d and the securing chain attached to the staple a and with the supply-hose h properly attached to the pipe B, is dropped overboard at the desired point from a boat or platform. When bottom is reached, the water-supply from a pump or water-main is turned on. The force of the water as it is ejected from the lower end of the pipe-nozzle B at the bottom of the anchor forces away the sand or earth immediately below and about it. The weight of the anchor settles it in the cavity left by the displaced sand or earth. The stream continuing, the anchor buries itself gradually deeper, and so much of the escaping sand or earth which does not pass up along the sides of the anchor, as it settles, is forced up through the escape-pipe C and falls on top of the anchor, thus helping to bury it. The anchor keeps on descending and burying itself as the hose plays until the desired depth is reached, when the water is turned off and the flexible hose h is pulled off and abandoned.

When two anchors are desired for securing the object, such, for instance, as the Atlantic City jetty or a breakwater, a second anchor of like construction, with the other end of the chain g of the proper length attached to it, is in a similar manner dropped to its position and sunk to the desired depth by the same operation and the jetty firmly secured to the bottom, as illustrated. When the anchor is once in position, it is securely held by the sand or earth above and below it.

In constructing the Atlantic City jetty the anchors varied from 4 ft. to 3 ft. across the tops, the smaller sizes being used close to the shore, and they were sunk to a depth of about 7 ft. below the bottom. The material penetrated was sand, and after the water was turned on it took about 20 minutes to sink each anchor. For the information from which this description has been prepared we are indebted to the officers of the Sea Coast Jetty Co.

THE ATLANTIC TRANSPORT LINE, largely an American corporation, has bought the fleet and business of the competing Wilson and Furness-Leyland Line, for about $5,000,000. Seven vessels are included in this purchase; all built within the past year or two and five of these are of 7,000 tons register. In addition to these the Atlantic Transport Line has five large cargo-carrying steamers built in England. These vessels will be 600 ft. long, 65 ft. beam, 44 ft. deep, with twin screws and engines capable of developing 16 knots. They will carry 300 first-class passengers, with 15,000 tons of freight and 1,500 cattle. This company sold all but two of its former fleet to the U. S. government a week ago for troop transports.

AN ELECTRIC CANAL MOTOR is to be tested by Mr. W. G. Wagenhals, General Manager of the Cincinnati & Miami Valley Traction Co., on the line of the Miami & Erie Canal. He proposes to run upon an ordinary standard gage track, laid along the towpath, a specially designed electric motor car weighing about 30 tons. It will be driven by a 100-HP. motor geared for five different speeds, ranging from one-quarter mile to ten miles per hour. The motor will take current from an overhead wire about 12 ft. above the track, and an electric shoe will also take the current from a conduit when bridges or culverts prevent the use of the overhead wire. If successful 100 steel barges will be built to be towed by the motor cars, each of which is to be capable of hauling five heavily loaded barges. The trains of barges would be run on regular schedules.

A MOTOR-SUSPENSION PATENT granted to Frank J. Sprague, Aug. 25, 1895, and now the property of the General Electric Co., has been sustained by a preliminary injunction issued by Judge Lacombe on June 21, against the Nassau Electric R. R. Co., of Brooklyn, N. Y. The motors were manufactured by the Steel Motor Co., of Johnstown, Pa. The injunction provides that within 30 days 250 motors must be removed; within 60 days 250 more; 250 within 90 days, and the balance in 120 days from date.

AN ELECTRIC POWER AND TRANSMISSION PLANT, recently installed in Yuba county, Cal., and described in the "Journal of Electricity" for May, has a canal 23 miles long, with a section of 9 ft. and 5 ft. × 2½ ft. deep. The flume is built of timber, is 5 ft. × 3 ft. and 7⅛ miles long. The pipe line is 850 ft. long and gives an effective head of 292 ft. It is 42 ins. in diameter and made of steel varying from ⅛-in. to ¼-in. Three 40-in. Pelton impact wheels are used, each wheel having two 4-in. nozzles. The capacity of each is 700 HP., with a speed of 400 r. p.m. These are directly connected to Stanley two-phase generators of 360 K-W. at 2,400 volts and a periodicity of 8,000 per second; 12 Stanley transformers of 125 K-W. each, with a primary voltage of 2,400 and secondary voltage of 16,700 are used. One transmission line is 18¾ miles long, and the other 7¼ miles. Poles of 30, 35 and 40 ft. were used spaced 44 to the mile, with 3 × 4-in. × 5-ft. cross-arms, and pins 18 ins. apart. The No. 6 B. & S. medium-hard drawn copper wires are supported on 5½-in. triple-petticoat Locke insulators.

ELECTRIC TRACTION IN BERLIN, says the "Elektrotechnische Zeitschrift," for March 10, 1898, is somewhat behind the practice in other German cities. This is due to the importance of the interests involved, the difficulty of making arrangements and the prohibition of the overhead trolley system in the central parts of the city. In 1896 the Berlin Tramway Co. established a system which had an overhead trolley for part of the way and an electric conduit system for the remainder; and a similar line was built about the same time by Siemens & Halske. But there are many break-downs with the conduit system employed and the general results are unfavorable. On March 1, 1898, another line was established combining the overhead trolley and accumulators. The four-wheeled cars weigh 16 tons, and the battery weighs 2.6 tons and is supposed to store sufficient electric energy to make the round trip over the 10,725-ft. section of line thus operated. The cars are about 33 ft. long and seat 28 persons, with 12 places outside. It is proposed to thus transform all the tramway lines in Berlin within the next three or four years. The system is about 184 miles in extent, and 14% of this will be operated by accumulators, and the remainder by the overhead trolley.

STREET RAILWAY FRANCHISES IN CHICAGO, according to resolutions adopted by the Chicago Federation of Labor, will not be acceptable "to wage-earners" hereafter unless they provide for 4-ct. fares, compensation to the city for the use of the streets, a 20-year limit to the life of the franchise, provision for the purchase of the system at the expiration of the franchise, eight hours as the maximum length of a working day for employees and freedom from persecution or discharge of employees on account of belonging to labor unions.

A STEAM-MOTOR OMNIBUS, built by M. F. Weidknecht, of Paris, is described as follows: It is intended to carry 16 passengers, all inside, and about 1,000 lbs. of baggage. The main feature of the design is the concentration of all the power-generating plant and transmission gear in front of and entirely distinct from the body of the vehicle, and this mechanism is carried on two 4½-ft. wheels acting as drivers. This gives a practically constant load on the axle, and is intended to give increased adherence with less tendency to sliding on the pavement. The body is suspended by three plate springs on two wheels placed well toward the rear. The length of the omnibus over all is 18 ft., with 11 ft. in body; the distance between axle centers is 7 ft. 10 ins. In the motor section the frame is made of light channel iron, to which the boiler, tank, etc., are riveted. The boiler is of the vertical multiple tubular type, with a super-heater, and a heating surface of 64.56 sq. ft. Coke is used for fuel and there is an automatic stoker attachment. The engine has two 4.9-in. cylinders, and develops about 20 HP. The power is transmitted from the main shaft of the engine, through gear wheels, to an intermediate shaft, and from the latter to the front axle by the usual chain and sprocket wheel. The two rates of speed provided for are 4.6 and 9.3 miles per hour, at 350 engine revolutions per minute. By regulating the admission of steam the speed may be run up to 12½ miles per hour. A hand foot-brake, on the rear wheels, and a hand screw-brake, on the driving wheels, are provided. Tests have been made showing a consumption of about 14 lbs. of coke per mile run on ordinary roads; though it is claimed that this can be reduced to 10.7 lbs. on good level roads. The weight of the omnibus is 4 tons 14 cwt. empty, and about 7 tons loaded.

AN ELEVATOR SHAFT to the summit of Mont Blanc, with a shaft 1½ miles deep and a 3½ mile tunnel to the bottom of the shaft, is proposed by a French engineer, Paul Issartier, of Marseilles. The tunnel would rise 600 ft. in 18,864 ft., terminating 7,500 ft. above sea-level. The vertical shaft would be 10 × 13 ft., and have a depth of 8,200 ft., and he proposes to excavate it from below. He has devised a "rising chamber," made of strong steel plates, in two stories divided by steel doors; on the upper floor would be the rock-drilling machinery, driven by compressed air. To avoid lowering the "chamber" out of the way of blasts, he would drill only on one side first, then roll the drilling machines to the other side and protect them by lifting steel doors. To catch the fragments of rock he proposes a series of strong steel gratings, placed at an angle of 45° and protected by fascines; these are supposed to permit the passage of the gases of explosives while retaining all the rock. On the lower story this rock would be "pulverized" and then passed down a 12-in. tube to the bottom of the shaft, and thence carried outside by a stream of water propelled by centrifugal pumps. The "chamber" would rest upon and be raised by strong steel racks placed in the four corners of the shaft. He presents no estimate of cost, and the proposition is chiefly interesting as a somewhat wild attempt to solve some novel engineering problems.

SIAMESE RAILWAYS, says "Indian Engineering," include the following, as the only lines in existence at present: The 13-mile line from Bangkok to Paknam, owned by a Danish company, and 87 miles of the line northward to Ayuthia. The latter line is to be extended to Khorax and will then be 164 miles long. A concession to a Danish company proposes another railway about 140 miles long, extending from Bangkok to Phetchabouri; but the most important line proposed is the extension of the Bangkok-Ayuthia railway northward 310 miles in a direct line to Zimme (Chiengmai).

BERLIN STREET PAVEMENTS, says Consul-General Goldschmidt, in answer to queries, had an area of 6,500,-405 sq. yds. on March 30, 1898. Of this area a little less than 74% is stone pavement; about 25% is asphalt and a little over 1% is wood. The use of asphalt is steadily increasing. The subsoil is a coarse, gritty sand, and forms an excellent foundation for the 8-in. concrete course underlying the 2-in. asphalt pavement. The average price for asphalt pavement in Berlin is $2.80 per sq. yd.; the contracts for laying the pavements run for 20 years, and the contractor keeps them in repair for five years free of cost to the city, and thereafter receives 10 cts. per sq. yd. per year for this service.

PHILADELPHIA'S AVERAGE DAILY WATER CONsumption for 1897 was 187 gallons per capita, with an estimated population of 1,385,734. In 1887 the consumption per capita was 89 gallons, the increase in ten years being more than 100%. The Chief of the Water Bureau, Mr. John C. Trautwine, Jr., very properly remarks that no one will pretend to believe that this 187 gallons per head per day represents water legitimately used for household or manufacturing purposes. It is simply, in great part, a waste of water that costs the city $3.16 per million gallons pumped 100 ft. high, and every gallon consumed in that city is pumped. For some reason, meter service is not regarded with favor in that city; though the application of some such check upon waste would seem to be largely demanded, and it would certainly be profitable to the city. There is evidently no lack of water, such as it is, and the recommendation to purify the supply by sand filters should be supplemented by the adoption of means to stop the needless waste of water.

CAST-IRON WATER PIPE at $16.60 per net ton delivered in Boston seems to be a record low price. The Warren Foundry & Machine Co., of Phillipsburg, N. J., lately made a contract with the Metropolitan Water Board to deliver 937 tons of 12 to 36-in. pipe at that price, the pipe to be delivered at Brighton, Forest Hills, Glenwood and Clinton, on the line of the new Metropolitan Water Supply. Nearly one-half the pipe ranged in diameter from 30 to 36 ins. We believe the transportation cost on the contract will be about $3 per ton, making the actual price received for the pipe at the foundry little more than $13.

THE STATUS OF THE SEPTIC TANK SYSTEM of sewage treatment, so far as the Local Government Board of England is concerned, has been made known by the action of the board in the Exeter case. In our issue of Jan. 13, 1898, we described the septic tank, including the trial and proposed plant at Exeter, England. The board has approved the loan necessary to carry out the scheme, but the approval is conditioned on the understanding that if the system is unsatisfactory the city will substitute some plan of chemical precipitation and artificial filtration, and also that the city will, at the start, supplement the septic tank system with land treatment exactly as would be required in the case of chemical precipitation; that is, provide one acre of filtration area for each 2,000 population. We are indebted to the London "Surveyor" for the above information.

ANOTHER SUCCESSFUL WAVE MOTOR PUMP is reported from California. It has been built by William and Edward Armstrong at Santa Cruz, Cal. From descriptions given in the Santa Cruz "Sentinel" and "Surf," it appears that the apparatus consists of a well 6 ft. diameter and 40 ft. deep, sunk in the rock a short distance from the water's edge, the bottom of the well being connected by a 6-ft. tunnel with the open sea, a float weighing about 800 lbs., which rises and falls in the well with the movement of the ocean wave, and a 6-in. direct-acting pump, whose plunger is operated by the motion of the float. The work now done by the motor is the spouting of a jet of water from a 2-in. hose pipe to a height of 50 to 100 ft. above the level of the cliff.

THE UNITED STATES AT THE PARIS EXPOSITION of 1900 is especially reported upon by Mr. Thomas W. Cridler, Third Assistant Secretary of State, and the successor of the late Moses P. Handy as Special Commissioner of the United States for the Exposition. Mr. Cridler's report is published as Senate Document No. 293 for the 2d Session of the 55th Congress. It contains his report upon the progress of the Exposition buildings and detailed plans and elevations of the spaces allotted to the United States in the several buildings. Mr. Cridler earnestly recommends, for commercial reasons, a full and representative exhibit by the people of the United States.