ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

VOL. XLI. No. 2.

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FOUR DAYS TO THE PACIFIC COAST, from New York to San Francisco, is now made by the government fast mail. The first run commenced at New York on Jan. 1, at 9:15 p. m., and was completed in 97 hrs. 55 mins., or with an average speed of 37.2 miles per hour, including all stops and transfers. The train was 1 hr. 9 mins. late at Buffalo; 16 mins. late at Cleveland; 2 mins. ahead of time at Chicago; 5 mins. ahead at Omaha; 30 mins., late at Ogden; 2 hrs. late at Palisade; 1 hr. late at Wadsworth, and arrived at San Francisco on time. The new fast mail train between New York and Portland, Ore., finished its trip, on Jan. 6, in 95 hrs. 55 mins., or in 15 hrs. less than by the former schedule. The new fast mail, over the Great Northern to Seattle, arrived in that city on Jan. 6, 3 hrs. 45 mins. behind schedule time. It encountered heavy head winds and snow and the worst storm of the season in North Dakota and Montana.

TRACK ELEVATION IN NEWARK, N. J., is requested by the Newark Board of Works for both the Pennsylvania and the New Jersey Central railways. The latter company must move first as the Pennsylvania road passes under the Central lines. The Central company has submitted an estimate of cost amounting to about $1,000,000 or $657,583 for construction and $350,000 for land. But the company objects to an elevated structure and the use of elevators for freight, and to acquire land for approaches as per the estimate submitted would prevent the company from economically and conveniently handling its business.

TRACK ELEVATION IN CHICAGO has made considerable progress during the past year, as shown by the annual report of Mr. John O'Neil, Superintendent of Track Elevation. From this report we take the following summary:

Track elevated during 1898..................	16.2 miles.
Track previously elevated	19.0 "
Total track elevated to Dec. 31, 1898........	35.2 "
Track yet to be elevated	14.3 "
Total track elevation provided for	49.5 "
Grade crossing eliminated during 1898................	95
" " " previous to 1898...........	86
" " yet to be eliminated..................	88
Total number of grade crossings provided for	249
Cost of work done during 1898................	$6,650,000
" " completed to Dec. 31, 1898......	12,700,000
" " yet to be done	4,230,000
Total estimated cost	$16,930,000

THREE SUBSTITUTES FOR THE ALLEN STREET Railway law were introduced in the Illinois legislature on its opening day. The Allen bill was passed by the last legislature and authorizes city councils to extend existing street railway franchises for 50 years. Ordinances providing for such action in Chicago nearly created riots a few weeks ago, and the ordinances were sidetracked. The substitute bills vary in detail, but two of their leading features are lower fares and the authorization of municipal ownership.

THE LOCOMOTIVE BUILDING INDUSTRY in 1898 showed the effect of the improved condition of business in that year as compared with the four preceding years. The contracting locomotive shops (not including the railroad shops), according to the "Railroad Gazette," built 1,875 locomotives in 1898, which was 624 more than in 1897. The number of locomotives exported was 386 in 1897 and 554 in 1898. The following table shows the yearly output of locomotive builders since 1888:

1888......2,180	1892......2,012	1896......1,175
1889......1,860	1893......2,011	1897......1,251
1890......2,240	1894...... 695	1898......1,875
1891......2,165	1895......1,101	

THE NUMBER OF FREIGHT CARS built by contracting companies (outside of railroad shops) in 1898, according to the "Railroad Gazette," was 99,809, as compared with only 43,588 in 1897; 51,189 in 1896; 38,100 in 1895, and about 18,000 in 1894. In 1890, 1891, and 1892, the output was in the neighborhood of 100,000 cars per annum. The building of freight cars thus appears to be a remarkably close index of the business conditions of the country.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Lehigh Valley R. R., near West Dunellen, N. J., on Jan. 9, and caused the death of 16 persons, while fully 50 were severely injured. The accident was a butting collision between a local passenger train and an east-bound excursion express. A freight wreck made it necessary to run trains in both directions over a single track for some distance. Through some error in sending or delivering orders, the two trains were dispatched against each other. They met on a curve where woods obstructed the view ahead so that the two engineers did not see each other's train until they were close together.

A BOILER EXPLODED in the Hewitt shipbuilding yards at Barking, England, near London, while undergoing a test, and, according to press reports, 9 men were killed and 40 persons were injured. The buildings in the vicinity were completely demolished and windows in houses a half-mile away were shattered.

THE STEAMSHIP "ST. PAUL" of the American Line, which has been overdue since Jan. 7, arrived in New York on Jan. 10, after a trip of 9 days, 20 hours and 16 minutes, the slowest run ever made by her. The delay was due to a crack in an elbow of the 16-in. main steam pipe leading to the starboard engine, which made it necessary to reduce the steam pressure to 100 lbs. As soon as the crack was discovered, without shutting down the engines, two heavy clamps were placed about the pipe and screwed up until the opening was practically closed. The injured section was then wound with ½-in. copper wire. The whole operation requiring about 1¼ hours. The accident was discovered when about 800 miles from The Needles, and the remainder of the voyage was made at a speed of about 13 knots, although this was reduced at times by the heavy head seas.

THE DAMAGE TO THE HOME LIFE INSURANCE Co.'s building by the fire of Dec. 4, 1898 (Eng. News, Dec. 8, 1898) has been set at $199,325 by the appraisers appointed to adjust the losses. This appraisal was made on the assumption of an original value for the building of $900,000. Of the total loss over $73,000 was on account of the injury to the marble front to the building. The remainder is almost entirely on account of damage to woodwork, trim, paint, tiling, steam pipes, electric light fixtures, elevators, etc. The structural ironwork suffered practically no loss. The total insurance on the building was $350,000, divided among seven companies.

A LANDSLIDE ON THE CANADIAN PACIFIC RAILway, on Jan. 7, dammed the Fraser River, near Spencer's Bridge, and flooded the fertile Nicola Valley. The slide included about 100 acres of a small mountain side, and it was from 20 to 50 ft. in thickness. The course of the river has been changed and barns and houses were carried away, but no lives were lost.

THE EXPERIMENTAL 8-IN. CAST-STEEL GUN, designed by Dr. R. J. Gatling, and under test at Sandy Hook, went to pieces, on Jan. 4, on the fifteenth round, under a pressure of 37,000 lbs. per sq. in. The charge of Dupont brown prismatic powder weighing 142 lbs. Five proof shots, with lighter charges, were fired three weeks ago; and on Jan. 3, nine shots were fired with normal powder charges for each, and with remarkably uniform normal pressures. The built-up guns, with which it was to compete, have successfully withstood pressures exceeding 80,000 lbs., while the "normal pressure" for them is 37,000 lbs. Out of the $40,000 appropriated by Congress for testing this gun, $15,000 was to be used for building a cast-steel mortar; the 8-in. gun was to be submitted to a test of 300 rounds.

THE BURSTING of the Gatling cast-steel gun, says Dr. R. J. Gatling, in a letter to the New York "Sun," is chargeable, in his opinion, to the overannealing of the breech of the gun. Members of the Ordnance Board were to be present at the mandrelling process, set for March 25, but unavoidable circumstances delayed their coming until March 29. As a result the gun was left in the annealing furnace eight days, instead of a little over two days, as intended. About 3 ft. of the muzzle-end of the gun was outside this furnace until the two last days, when a change was made submitting it to heat. After the gun had been mandrelled, samples from the muzzle-end gave a tensile strength of about 96,000 lbs. per sq. in., while samples from the breech-end gave less than 60,000 lbs. These tests were made by the government inspector, and Dr. Gatling charges that the unfortunate overheating of the main part of the gun was the cause of the failure by injuring the quality of the metal to the extent indicated by the tests. Dr. Gatling is still confident that his process is all right in theory, and that cast-steel guns will yet supersede built-up guns.

FRENCH SUBMARINE TORPEDO-BOATS are described by the Intelligence Office of the U.S. Navy Department. Lieutenant Darefus, of the French Navy, has been at work for the past eight years on boats of this type, and six of his designs are to be built in 1899. These boats are not fully described, but they are to be 111 ft. long, 12 ft. beam, 5 ft. maximum draft on surface, 106 tons displacement, and the 217-HP. engines will operate a single screw and drive the vessel at a 12-knot speed at the surface. These boats will be identical with the "Narval," now building at Cherbourg. They are to have a surface-steaming radius of 250 knots, and an underwater radius of 100 knots at a 10-knot speed. On the surface they will be propelled by steam, and by electric accumulators below the surface, with dynamos on board to charge the accumulators. One of them, the "Zede," has been tested at Toulon, and is said to have made an underwater trip of 40 miles in the company of a seagoing torpedo-boat.

THE IRON AND STEEL TRADE NEWS of the week is of more than usual importance. The American Steel & Wire Co., of Illinois, which was organized a year ago, with a capital stock of $24,000,000, and which consolidated into one concern thirteen plants, including seven owned by an earlier consolidation, the Consolidated Steel & Wire Co., of Chicago, is now preparing to reorganize, with $90,000,000 capital, of which $40,000,000 is to be 7% cumulative preferred stock and $50,000,000 common stock. The new corporation will be known as the American Steel & Wire Co., of New Jersey. A syndicate has been formed to furnish $28,000,000 capital, to be used in the purchase of other properties or of a majority of their capital stock. It is stated in the advertisement of J. & W. Seligman & Co., Bankers, that the acquisition of the following plants has been assured: Washburn & Moen Mfg. Co., Worcester, Mass., and Waukegan, Ill.; Worcester Wire Co., Worcester, Mass.; Cleveland Rolling Mill Co., Cleveland, O.; Oliver & Snyder Steel Co., Oliver Wire Co. and Pittsburg Wire Co., Pittsburg, Pa.; Cincinnati Barbed-Wire Fence Co., Cincinnati, O.; Laidlaw Bale & Tie Co., Joliet, Ill., and Kansas City, Mo.; Consolidated Barb Wire Co., Lawrence, Kan., and Joliet, Ill., and Newburgh Wire & Nail Co., Newburgh, N. Y. It is proposed to exchange the stock of the American Steel & Wire Co., of Illinois, for stock of the New Jersey corporation on the basis of one share of preferred and 0.6 share of common stock in the new company for each share of preferred stock, and 1.2 shares new common stock for each share of the old. A press rumor states that arrangements have been made by which the new company will also obtain practical control of the Tennessee Coal, Iron & Railroad Co. There are rumors of an agreement between the steel rail manufacturers to advance the price of rails, which is to be ratified at a meeting to be held soon. Beams and channels have been advanced $2 per ton by the six mills composing the Beam Association, and other shapes have been advanced $1 a ton. The new year opened with every branch of the iron trade in the most active condition it has known in many years. The production of 1898 will be considerably greater than that of any previous year, and the present prospects are that it will be far exceeded in 1899. Many of the mills are sold far ahead. The advance in prices thus far, however, have been moderate.

THE PLANT OF THE CATASAQUA IRON CO., in Lehigh county, Pa., was sold a few days ago for $16,000 as old iron. The rolling-mill plant is out of date and cannot compete with modern processes. In 1882 this mill had an output of 36,000 tons of finished iron, valued at about $2,000,000, and it employed over 600 men with a monthly payroll of about $28,000. Active operations began here in 1873, and the beginning of the end was a long strike among the employees in 1890.

THE BOILER PLANT for the new universal plate mill of the Carnegie Steel Co., at Homestead, Pa., has been designed with special reference to saving of labor. There are 16 Cahall boilers, aggregating 4,000 HP. The coal is fed by chain-grate mechanical stokers, from storage bins, and the ashes are also removed by mechanical means. The feed pumps are regulated by the height of water in the boilers. Three men only are required to operate the plant, these being machinists who will keep the machinery in good order—one looking after the coal-feeding apparatus, one the pumps, and the third the ash-removing mechanism.

DIFFICULT PIER CONSTRUCTION, MANHASSET VIADUCT, LONG ISLAND R. R.

By Wm. A. Cattell, M. Am. Soc. C. E.*

The extension of the North Shore Branch of the Long Island, R. R., from Great Neck to Port Washington, which was completed and opened to traffic during the summer of 1898, necessitated the construction of a steel viaduct

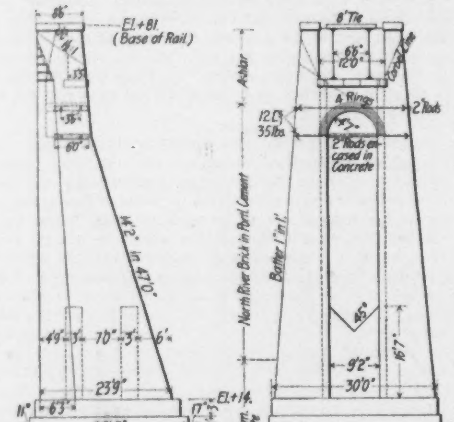


Fig. 1.—General Plans of Special Pier Construction, Manhassett Viaduct, Long Island Ry.
Wm. A. Cattell, M. Am. Soc. C. E., Engineer.

across the head of Manhasset Bay, 678 ft. 8 ins. in length and 75 ft. in height above the meadow line.

The pier at the west end of this viaduct was constructed under conditions which were rather unusual, and which became a source of no little anxiety to the engineer, and unforeseen expense to the railway company before the work was finished.

As is too frequently the case in engineering work, the surveys were made and the plans and specifications prepared under "forced draft," and the contract was awarded and the work commenced before there had been time to make reliable borings. Soundings with a ¾-in. pointed rod were made across the meadow, which indicated hard bottom at various depths below the surface of from 10 to 36 ft. Hence no difficulty was anticipated in securing suitable pile foundations.

The maximum economy between foundations, superstructure, grading, etc., was carefully figured, and the location, height and spans of the viaduct were fixed accordingly. These computations established the west end of the viaduct at a point 4,673 ft. east of Great Neck Station. Between these points, on the original grade, there was a summit cut containing 85,000 cu. yds., through which the line descended towards the viaduct on a 1½% grade. The viaduct was so located that all of the material in this cut could be utilized as embankment.

It was the original intention to support the west end of the first span of the viaduct, a 90-ft. plate girder, on a masonry pier built up from a pile foundation, through the embankment, which would, of course, entirely surround it except at the top. Under ordinary conditions this pier would have sustained only a vertical pressure from the weight of the girder and its live load, and would not have been required to act as a retaining wall to any great extent.

The engineer's previous experience with construction work on Long Island led him to believe that while there would be small pockets of clay in the cut, the bulk of the material to be removed from the cut, and of which the embankment would be formed, would be sand and gravel. The cut, however, proved to contain extensive deposits of saturated clay, and in sinking the coffer-dam for the foundation of the pier it was discovered that a stratum of wet clay, 3 to 4 ft. in thickness and only a few feet below the surface of the ground, extended from the foundation 150 ft. or more up the hill. The slope of the surface of the ground under the proposed embankment was about 40 ft. in 100.

Great difficulty was experienced in keeping the derricks on the uphill side of the foundation in place. Masses of earth on which the derricks rested would break loose from the surrounding ground, and derrick and all slide down the hill. It was, therefore, evident that not only would the embankment be composed largely of wet clay, but that even if it could be formed of dry sand and gravel, it would rest upon a base of clay with an inclination so steep that the whole mass would slide down the hill, and the pier, for the section which it presented to this mass would be required to act as a retaining wall. To make matters still worse, the founding line of the pier was in a stratum of fine white sand containing about 20% of clay.

Various means of overcoming the difficulties were considered, and at the engineer's request Prof. W. H. Burr, M. Am. Soc. C. E., was called in consultation ,and the form of pier and foundations shown in Fig. 1 was adopted and built. While the pier was designed to act as a retaining wall for its entire section at right angles to the thrust of the embankment, it was given the wedge shape shown to offer as little flat surface to this thrust as possible, and to allow the material to pass through and on either side of it. Every precaution was taken to secure stability in foundations and superstructure of the pier. The bearing piles were sunk with a water jet and the spur piles were driven with a 3,200-lb. hammer, and the concrete and brick work constructed with great care.

FIG 2.—VIEW OF VIADUCT SITE SHOWING PIER AND "FLOW" OF EMBANKMENT FILLING.

So much clay and water were encountered in the cut that it was found necessary in order to open the line for the summer traffic to change the grade and lessen the amount of material to be removed. The gradient descending towards the viaduct was changed from 1½% to 2½%, giving 35,000 cu. yds. less material to move. A temporary trestle was built from the pier back to the embankment, which is now being filled in with dry sand and gravel taken from the east side of the bay.

The portion of the embankment taken from the clay cut was exceedingly troublesome. Great masses of the material would slide out from the sides and run 150 to 200 ft. beyond the normal slope lines. In the worst slide that occurred, some 500 tons of the material moved in a few seconds from the side of the embankment to the very doorstep of the small dwelling house seen at the extreme right of Fig. 2, 200 ft. beyond the toe of the slope, crushing or carrying before it several small outhouses which stood in front of the dwelling. At times during the progress of the work, the material taken from the cut and dumped on top of the embankment would flow down its sides with the consistency of molten lava and spread all over the meadow, Fig. 3. This sliding and flowing occurred during unusually wet weather, and the bank has since stiffened up considerably, but there is still a perceptible movement in the embankment which will probably continue for several years. There is little doubt that but for the peculiar form of the pier, there would, under such conditions, have been great difficulty in keeping it in place.

*Richmond Hill, N. Y.

THE OLD AND NEW SUSPENSION BRIDGES OVER THE NIAGARA RIVER AT LEWISTON, N. Y.

(With two-page plate.)

The construction of a steel arch to take the place of the old highway suspension bridge crossing the Niagara Gorge just below the Falls is responsible for the erection of the structure which is illustrated on our two-page plate this week. This bridge will cross the river at Lewiston, N. Y., and the cables of the old highway suspension bridge will be used in constructing it. When completed the new bridge will be the only structure of its type crossing the Niagara Gorge, the two suspension bridges near the Falls having been replaced by steel arches. (Eng. News, Jan. 1 and Aug. 6, 1896, and April 22, 1897.) It will also be the second suspension bridge to be erected on the site.

The Old Lewiston & Queenston Suspension Bridge.

As just stated, the new bridge is not the first one to be erected at this point. From 1851 to 1864 a suspension bridge occupied the site that the present bridge will occupy; and at the time of its construction it bore the distinction of having the longest clear span of any bridge in the world. The engineer of this bridge was Capt. Edward W Serrell, now General Serrell, and his assistant was T. M. Griffith. The points of support were 1,042 ft. 10 ins. apart, and the roadway was 850 ft. long. The platform, or deck, had a width of 21 ft., and the stiffening trusses formed railings on each side. The versed sine of the cables was 87 ft. The strength of the structure was fully equal to the travel demands of that day.

A pretty comprehensive idea of the old bridge is furnished by the illustrations on our two-page plate, which have been reproduced from the original detail drawings, loaned to us for that purpose by General Serrell. Fig. 2 is a general view of the gorge with the bridge crossing it, reproduced from a rare old lithograph, for the use of which we are also indebted to General Serrell's courtesy. It will be noticed that a shelf was cut out of the rock bluffs at each end of the bridge to form the approaches. The method of guying the structure against swaying is also clearly indicated by this illustration. Fig. 3 shows the anchorage and tower construction, and Fig. 4 is an enlarged drawing of the anchor, of which there were five (one for each strand of cable) in each anchorage. Referring to Fig. 4, e is the forged, square iron anchor claw having a shoulder at its upper end; b is the forging shaped like a key blank, which is attached to the cable, a, and hooks over the shoulder on e; c, c, are square rings which bind b and e together and prevent the dislocation of b; and d, d, are iron blocks separating the shoulders on e and b in the manner clearly indicated by the drawing. It is by these blocks that adjustment of the cables was secured, the cable being obviously lengthened and shortened by decreasing and increasing, respectively, the number of blocks. These anchors were forged from refined scrap.

In these days of powerful and speedy rock drilling machinery, it is interesting to notice in connection with the anchorage construction the device which was employed to sink the holes for the arms of the anchor. This device is shown by the sketch, Fig. 5, which also shows the drills with detachable steel cutting edges which were used. The drill, it will be seen, was an ordinary churn drill attached to a spring pole and sliding in guides, and was operated by hand. A device similar to this was used with success in constructing the St. John Suspension Bridge, at St. John, New Brunswick, which was also designed by Capt. Serrell.

Figs. 6 and 7 show, respectively, a cross section of the bridge and a short length of the wooden stiffening truss. These two drawings also show the arrangement of the cables and the method of suspending the wooden floor beams from them. Each cable consisted of five strands laid parallel to each other in the same horizontal plane. Each strand was made up of 250 wires laid parallel, and each 1,275 ft. long between anchorages. The wires in each strand were bound together into a circular section and wrapped, and to protect them further against corrosion each wire was given a bath in a mixture of boiled linseed oil and Franklinite. As indicating the primitive state of the wire drawer's art in those days it is stated by Gen. Serrell that long skeins of wire were employed for the first time in this bridge, and that they were made by welding together short lengths of wire rods, in a deoxidizing flame, formed by placing three tuyers in a blacksmith's forge, so that their blasts would converge over and on an anvil. The workmen struck through the flame when welding. The rod was then drawn into a long wire. By this means wires as long as 2,640 ft. were made. Peter Cooper was the maker, and Capt. Serrell devised the plan. The method of stringing the parallel wires forming a strand is shown by Fig. 8.

A study of the drawings here reproduced will bring out other primitive features of suspension bridge construction as exemplified by this early bridge, but space need not be taken to mention them here. For the use of these drawings and much of the information given here we are indebted, as already stated, to Gen. Edward W. Serrell, the engineer of the bridge.

The bridge was opened on March 20, 1851. Early in 1864, a great ice jam formed in the river below the structure, and for fear the passing out of the ice would carry the guys away, they were loosened from their anchorages and placed out of danger from this source. The ice moved out without doing the damage feared. Fair weather came. Travel was light over the structure at that time, and the passing years had proved the investment in the bridge to be unprofitable. It was simply ahead of the times. The officials of the bridge were thoughtless about the guys, and so when a heavy gale swept down the chasm, the guys were still unfastened, and after being swung back and forth by the hurricane, the bridge floor parted on the morning of Feb. 1, 1864, and a large portion of it fell into the river. The cables did not part, and in fact they remained standing until finally cut away by hand last year. The accident was the end of the bridge for all practical purposes, however.

FIG. 3.—VIEW OF MATERIAL AT FOOT OF EMBANKMENT SHOWING LAVA-LIKE APPEARANCE OF FLOWING CLAY.

The companies in control were not strong enough financially to rebuild the deck of the bridge, and so it was left a wreck, dropping away piece by piece, until last fall, when the cables were cut away to make place for the new construction. But it had served its purpose. It had accommodated travel across the gorge at a time when Lewiston's prospects were bright, and it had marked the advisable site for a structure to be built when the electrical era struck Niagara, and made a demand for a belt line electrical railway about the lower Niagara. Thus, while financially unprofitable, it had done some good.

The New Lewiston & Queenston Suspension Bridge.

The new bridge is being built by the Queenston Heights Bridge Co., a Canadian incorporation, and the Lewiston Connecting Bridge Co., a New York State incorporation. It will span the river above the navigable portion of the stream, and will stretch from the side of the Lewiston mountain over to Queenston Heights on the Canadian side. It will adhere closely to the lines of the old bridge, and its general location will be about the same. About 800 tons of metal will be used in its construction, and the cables will weigh about 200 tons. The contract for the substructure was awarded to James Stewart & Co., of St. Louis, Mo., and that for the superstructure to the New Jersey Steel & Iron Co., of Trenton, N. J. The consulting engineer of the work is Mr. L. L. Buck, M. Am. Soc. C. E., and the engineer is Mr. R. S. Buck, M. Am. Soc. C. E.

The cable span from tower to tower will be 1,040 ft., and the span of the stiffening truss 800 ft. There will be two short shore spans, that on the New York side to be 34 ft. 6 ins. long, and that on the Canadian side to be 19 ft. 6 ins. long. From center to center of trusses, the width will be 28 ft., while the width of the roadway in the clear will be 25 ft. This width will afford room for a single track electric railway through the center, with carriageways on each side of sufficient width for teams to pass. There will be no walks provided for pedestrian travel, as not many foot passengers are expected. The floor will be made of 2-in. oak plank laid crosswise.

The stiffening truss will extend about 4 ft. above the floor, and the only railings will be light strips of iron flats, reinforced with half round oak timbers. The clear height of the bridge above high-water mark will be about 65 ft., and it will be about 15 ft. above the tracks of the Niagara Falls & Lewiston R. R., better known as the Gorge Road. The capacity of the bridge will be such that it will safely carry the heaviest trolley cars, together with a uniformly distributed load of 40 lbs. to the sq. ft. over the entire structure.

The number of towers will be four, two on each side of the river. These towers are located on the top of the bluff on the site of the towers of the old bridge. The greater part of the stone of the old towers was used in the bases of the new towers. In the construction of the towers for the new bridge it was found possible to preserve the two inscription stones of the old bridge. The new stone used in the New York towers was obtained from the Buffalo quarries, and from the Queenston quarries for the Canadian towers. The bases of the towers on the New York side are 13 ft. square, and those on the Canadian side are 12 ft. square. On the New York side the towers stand about 28 ft. back from the edge of the bluff, and on the Canadian side this distance is 15 ft. the ledge on the Canadian side being more solid than on the New York side. The height of the New York towers is 26 ft., while the Canadian towers are but 18 ft. high.

Four cables will support the bridge, two running over each tower. Each of these cables will be composed of fourteen 2¼-in. galvanized cast steel wire ropes. The versed sine of the cables will be 87 ft. The ropes for the cables, as already stated, will be those of the old upper suspension bridge, which was taken down last Fall. These ropes will be cut in half. It will be recalled that the span of the upper suspension bridge was much greater than that of the new bridge, and that the anchorages were quite a distance back from the towers, which permits of the cutting of the cables, as stated. Their length, however, will not be quite sufficient to reach back to the anchorages, and for this reason about 75 ft. at each end of the cable span will be made up of eye-bars. The cables will be anchored in solid rock, about 150 ft. from the edge of the bluff, the shafts being filled with concrete. Over the point where the suspended span and the approach spans meet, the cables will be supported by rocker-bents—in order that the strain of the heavy trolley cars passing onto the suspended span from the approach spans may be suitably met.

On both sides of the river, approaches to the bridge have been constructed. The width of the approach on the New York side is 25 ft. in the clear, and it will accommodate double tracks for trolley cars. The Canadian approach is of the same width as that on the New York side, and follows the line of the old approach, which was re-excavated. On it double tracks will also be laid. These tracks will connect with the tracks of the Niagara Falls Park & River Ry., on the Canadian side, and on the New York side connection will be made with the Niagara Falls & Lewiston R. R. Face walls have been constructed along the approaches on both sides of the river.

Last fall the cables of the old bridge at this point were cut loose and allowed to drop into the river. Efforts will be made to recover all or a portion of them. The old cables and anchorages were found in a remarkable state of preservation, even those parts which for 35 years had been buried in mud caused by a landslide. It is expected that if the weather is not too severe about 60 days will be consumed in erecting the new superstructure. There is every prospect of the bridge being completed in the early spring, and open for travel next summer.

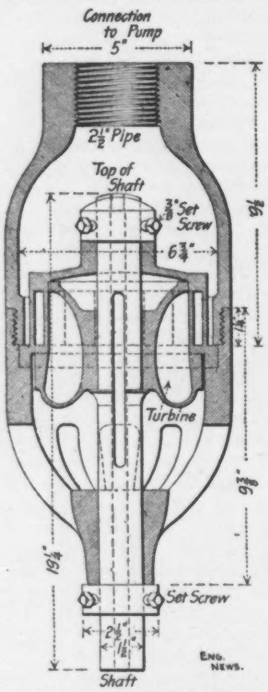
The officers of the Queenston Heights Bridge Co. are: President, Thomas G. Blackstock, Toronto, Ont.; Vice-President, C. H. Smyth, Clinton, N. Y.; Secretary and Treasurer, J. M. Bostwick, Buffalo, N. Y. The following are the officers of the Lewiston Connecting Bridge Co.: President, William B. Rankine, New York; Vice-President, J. T. Mott, of Oswego; Secretary and Treasurer, J. M. Bostwick, of Buffalo.

For the information respecting this new bridge we are indebted to Mr. Orrin E. Dunlap, Niagara Falls, N. Y.

HYDRAULIC PILE SINKING MACHINE.

In sinking piles at the harbor improvement works at Owen Sound, Ont., very successful results were obtained from the use of a machine used to bore a hole for the pile. This machine was designed as an improvement upon the method of sinking the piles by means of a water jet from a pipe at the side of the pile.

The machine, which is shown in the accompanying cut, consists of a vertical metal cylinder with hemispherical ends, 6¾ ins. inside diameter and



Hydraulic Pile Sinking Machine. J. C. Culnane, Inventor.

17⅝ ins. high over all. The shell is made in two parts, put together with a screw joint, and at the middle is a partition or diaphragm, forming a turbine chamber. The hollow boring bar or shaft extends up through the diaphragm, and has a cap bearing on the upper side. On the upper end of the shaft is secured a turbine wheel, while at its lower end it is fitted with a pair of rectangular blades, set spirally, but these blades are not shown in the drawing. At the top of the machine is a connection for a line of wired hose from a duplex steam pump, with cylinders 14 × 7 × 10 ins., supplying water under a pressure of 100 lbs. per sq. in.

The water in the upper part of the cylinder passes down the side of the turbine chamber and through suitable ports to the turbine, which is caused to revolve, together with the shaft and cutting blades. The waste water from the turbine passes into the lower part of the cylinder and escapes through bottom openings under pressure, thus serving to loosen the surrounding material. Some of the water also passes through the hollow shaft and forms a central jet at the bottom. The machine is lowered from the pile driver and cuts its way to the required depth. It is then quickly drawn up, and the pile (hanging ready in the leaders) is dropped in, and sent home with a few taps of the pile hammer.

On the work at Owen Sound, rock elm piles 12 × 12 ins., 40 ft. long, were driven at first with an ordinary pile driver having a 2,000-lb. hammer falling 20 ft. The piles were pointed, but did not drive easily. In a test, after 200 blows had been given in from 35 to 40 minutes, the pile split at the head, and a piece was sawed off. After 15 more blows the pile refused to move, leaving 3 ft. 3 ins. to be cut off above the given level. With a hydraulic boring machine, a similar pile was put down in three minutes, being settled first by the dead weight of the hammer, and then by a few blows with a fall of not more than 2 ft. By this method 80 to 100 piles were driven to a depth of 20 ft. in a working day of 10 hours.

This machine is the invention of Mr. J. C. Culnane, of Fairport, Ont., who was one of the contractors on the protection works, and he is now arranging to introduce it in this country.

INCREASE OF THE STRENGTH OF STEEL A FEW DAYS AFTER MANUFACTURE.

In the discussion of Mr. W. R. Webster's paper on Specifications for Structural Steel and Rails, read before the Franklin Inst. (Eng. News, Nov. 24, 1898), Mr. A. A. Stevenson, of the Standard Steel Co., Burnham, Pa., gave some interesting results of tests showing that the strength of railway tire steel is increased by allowing a few days' time to elapse between the time the product is finished and the tests are made. We quote from the Journal of the Franklin Institute of Jan., 1898:

You state that "the quality of steel depends (1) on its chemical composition; (2) on the treatment it received in the course of manufacture." I would go a step further, and say that, in my opinion, as far as open-hearth steel is concerned, the physical results, to a certain extent, depend on manipulation of the bath in the furnace.

Concerning the relations between the chemical composition and physical results, I must say I have been somewhat surprised to find how close this relation is. The point in question has been brought out strongly in test work we have recently done on some tires made for a foreign government to a rather difficult specification.

I heartily agree with the effort to have the conditions under which tests are made reduced, as far as possible, to a standard. In my own experience, I have found a great many tests that were practically valueless for comparative purposes on account of unknown or varying conditions.

I think it is desirable not only to have dimensions of test piece and pulling speed standard, but also important to have a record of the period elapsing between the time product is finished and tests are made. That a change takes place in steel after finishing, which materially affects the physical results, cannot be questioned.

In connection with above, the following figures may be interesting. Test pieces were all cut from tires and duplicate tests, as far as possible, from the same part of the tire, as, owing to section of a tire and process of manufacture, tests from different parts of same section show a variation.

Elastic limit.	Ultimate strength.	Elongation.	Reduction.	Remarks.
53,490	107,460	15.00%	19.20%	Pulled within 3 days after tire was made.
56,037	108,700	16.30%	24.30%	Ten days later.
50,940	.99,590	14.00%	22.20%	Pulled within 3 days after tire was made.
53,000	103,464	18.00%	27.40%	Ten days later.
56,037	111,050	10.00%	12.37%	Pulled within 3 days after tire was made.
61,130	111,410	15.00%	21.50%	Ten days later.
70,370	121,250	11.00%	14.01%	Pulled 5 days after tire was made.
71,980	121,970	14.00%	17.89%	Seven days later.
65,080	121,470	11.50%	13.55%	Pulled 7 days after tire was made.
64,400	121,160	13.00%	16.30%	14 days later.

The tests were all pulled at the same speed. The dimensions of the first six test-pieces were 2 × 0.5-in. and of the last four 2 × 0.798-in.

WATER-TUBE BOILERS A NECESSITY—A WAR LESSON.

By J. K. Robison, Passed Assistant Engineer, U. S. N.

The United States Navy has passed through a glorious war—glorious because victorious—but most glorious because every man in the navy has done his duty. This is true from those in the highest command to those of the lowest ranks. There have been many cases of men that have done more than their duty, but no single case is recorded of a failure to perform his duty on the part of anyone in the navy.

To engineers it is a matter of no small amount of pride that the machinery of the vessels of our navy has been satisfactory under the trying conditions of war. Naturally many obstacles have had to be surmounted, many mishaps have occurred and makeshifts used; but there have been no disasters, and the use of makeshifts has been the mark of the resourceful engineer.

*Condensed from a paper in the "Journal of the American Society of Naval Engineers."

One thing in the matter of engineers' supplies was very prominently developed—the value of uniformity in the stores and spare parts required by different ships. It was impossible to predetermine exactly what stores would be required by any particular ship. It would have been a great advantage if such things as grate bars and boiler tubes could have been carried on the supply ships that would have fitted any ship of the fleet. Instead of this, it was necessary to carry such stores of separate fixed patterns for every ship requiring them. These patterns were not always at hand, being scattered throughout the different naval stations and shipyards. The value of uniformity in design was well developed.

The great increase in the materiel of the navy, that began even before the war was declared, together with the even greater increase in the personnel that accompanied this increase in the materiel, brought into play conditions that could not be entirely provided for. The doubling of the personnel of the navy during the war meant that on board all of our ships came new men, men unused to naval life and discipline, and, in many cases, unused even to the sea.

It required time to accustom these men to the duties that they were called upon to perform. This time was the one thing that could not be given them. To properly perform their duties water tenders must be thoroughly familiar with the ship on which they serve. Oilers must know their engines before being able to do their best work. Machinists had to learn what to watch, and how to get around the ship to make repairs. Many machinists had even to learn how to stand an engine-room watch. A man cannot necessarily run a marine engine well because he is a good lathe hand and makes good tools, while it was from this class of men that came a large part of the machinists enlisted during the war.

Naturally, ships were forced to go to sea with green crews, and, at the best, with such a crew, it was impossible to obtain the best results. This was particularly true in the fire-rooms. The engines would run well enough, but it was hard to get the steam to run them. The firemen were not the best firemen, and they were unused to the ships they were on. They could not obtain the best possible results from our boilers.

What but a superior fire-room force furnished the steam that made a 16-knot battleship overhaul a 20-knot cruiser? Both ships were well designed as regards the machinery. And there are other ships than the "Oregon" that would have done as well as she did if given the same advantages. The conditions of the war made necessary the use at all times of full boiler power. At the commencement of the war this was due to the necessity of being always prepared for a chase; later, off Santiago, it was due to the necessity of being always on guard against such a sortie as came on July 3. It is true that not all of our ships were maintained in this state of complete preparedness, but the "Oregon" certainly was, and this to such manifestly great advantage that it would seem that all should have been so kept.

This practice of lying with boilers always in use, or ready for use, was a natural one, and will always be required for such extended service as our fleet had to perform, and, indeed, in all naval operations in time of war. When great boiler power is given a ship, it must certainly be intended for use in time of war. Its constant use, however, as thus required, entails some very serious disadvantages, which must not be lost sight of.

Lying with all boilers in use and with the fires kept clean, so as to be ready for emergencies, with steam in the engines, required the expenditure of a large amount of coal. This "standing by" costs heavily in coal. There was always, in spite of the presence of colliers with the fleet, much difficulty with the coaling question. It was often not possible to coal in the open sea, and, even after Guantanamo Bay was seized and a sheltered coaling station secured, much time was lost in coaling.

The work for the men that were forced to stand steaming watches for such a long period in the intense heat of the fire-rooms and engine-rooms was very hard. It was not so hard as it would have been if they had had to keep the ships under full speed all this time, but it was quite as hot and it was very trying. The continued strain, with the terrible heat, bleached these men snow-white, though those on deck were tanned almost black by the tropical sun. The men from Cuba who came home after doing the work in the fire-rooms, looked as if they had gone through a long spell of sickness. This was the effect of the strain due to such unusually prolonged hard work. This work was well done, but the men were weakened, and after a comparatively short time they were not capable of such exertions as they could have made at the first part of the war. Naturally, this decreased the power of the ships below what it should have been, and this, too, is a very important point. The condition of the crew must be considered, both for humane reasons and because the efficiency of the ship is in question.

The use of all boilers increased the loss of feed water because the number of leaks was increased. It is not possible to determine this absolutely, but it is thought that a very large part of the loss of feed water occurred at the boilers. It was very soon developed that this was a matter of vital importance. The evaporating plants were frequently insufficient to maintain the freshness of the feed water after they had supplied the necessary drinking water for the crew. This, of course, made necessary the use of salt feed as a make-up, and rendered fresh water in the boilers out of the question. The length of time that the ships were called upon to remain away from a naval base or a repair station must be considered. Evaporating plants, ordinarily ample, soon become insufficient, as a direct result of fouling, due to use. In several cases one of the boilers was told off to do duty as an evaporator and thus limit the trouble from the use of salt water to one boiler. This measure was generally successful as far as it went, but it destroyed in large measure the efficiency of the boiler so used.

With the boilers always in use they soon become dirty, not only on the fire side, but also on the water side of the boilers. Leaky condensers gave much trouble, and it has been seen that salt water in the boilers was a common occurrence. Now these boilers, being always in use, were inaccessible for repairs or cleaning, and much efficiency was lost as a result of the scale that accumulated upon the heating surfaces. There are several cases recorded of the dropping of the crown sheets of furnaces from this cause. In at least one case, that of the "Indiana," a battleship was thus disabled for a considerable time.

This matter of fresh water for the boilers gave much trouble. Even the water sent the fleet by the water boats was sometimes not satisfactory. In torpedo boats using light tubulous boilers, the dirt in the water frequently caused severe priming at high speeds, and it was not possible to use a high-forced draft on this account.

Another point in the matter of the working of the machinery that must be considered is the comparatively low sustained speeds obtained. The mixed crews, with fires that soon become dirty, and that never were thoroughly cleaned owing to lack of opportunity, the dirty boilers, the terrible fatigue due to the prolonged hard work, made the combustion of coal per square foot of grate surface comparatively low. In practice it was found that the maximum speed was not far from that obtained ordinarily on natural-draft trials. By natural draft is meant real natural draft without any blowers in use. The use of blowers just about brought up the speed to what it would have been at the start if no blowers had been used.

The foregoing represents some of the conditions that have developed during this war, and that will again develop in any war. They are conditions that affect greatly the efficiency of the machinery. These conditions are facts, and they must be met and considered in making designs of war ships.

Let us consider what is required to properly meet these war conditions: As far as possible designs should be uniform. This applies not only to engines but also to boilers. It may be said that the length of grate cannot always be the same, but there is a length beyond which working the fires is very difficult. With a constant length of grate it is possible to have a constant length of boiler tubes, and by using one diameter of boiler tubes we could have both grate bars and boiler tubes that would be interchangeable among all ships.

The evaporating plants must be large on all ships. The trouble from the use of salt water in boilers cannot be entirely prevented, as condensers will sometimes leak; but it must be reduced as much as possible. It must never occur, on account of the insufficiency of the evaporating plants, to supply make-up feed after supplying drinking water to the crew.

The boilers must have a large grate surface so that steam can be furnished with readiness to the engines. To go further, our contract-trial speeds should be obtained by burning not much more than 25 lbs. per sq. ft. of grate surface under the boilers. This would insure the ability to attain this speed, a maximum speed in practice, without great difficulty. The boilers should be divided into small units so that it will be possible to overhaul them, one by one, without at any time making any great inroad into the steam-producing plant.

We want to avoid the great fatigue to the men, the great loss of feed water, the rapid fouling of the boilers incident to their being maintained at all times with lighted fires under them all. We want to avoid any great expenditure of coal incident to keeping the vessel at all times in complete readiness for action. Our boilers must be accessible to repairs and cleaning, inside and out.

To fulfil these requirements we must have boilers that are capable of generating steam quickly from a cold boiler. Such boilers could be maintained with heavily primed fires ready for lighting, but not lighted until required, and such boilers would be capable of furnishing a full supply of steam to the engines at short notice. By the use of hydrokineters, the water in these boilers could always be kept hot.

The wear and tear on the ships would be decreased and could be controlled. The ship being fitted with such boilers, a full watch would not be required at all times in the terrific heat of the fire-rooms; having the men within call would be sufficient. The crew would not be worn out with hard work to such a deplorable extent as now obtains.

As the time required to raise steam from a cold boiler is largely due to the time required to heat to the boiling point the water contained in the boiler, in order to have boilers that will be capable of raising steam quickly, we must have boilers having a small amount of contained water as compared with the cylindrical boilers that are now in use.

The foregoing means that water-tube boilers are tactical necessities, as this type of boiler is the only one that is capable of being divided into small units, and containing a small amount of water. The arguments for and against water-tube boilers have been gone over again and again until they are threadbare, but the fact that we must have boilers that are capable of being divided into small units, and that are capable of quickly generating steam from a cold boiler, must settle the question. Whatever the faults and virtues of this general type of boiler, it must be used to satisfy the manifest requirements of the service. War conditions that we have found to exist, and that will again exist, require the use of water-tube boilers.

We find that water-tube boilers must be used on men-of-war, but we also find a great deal concerning the type of water-tube boiler that must be used. It may or may not be capable of sustaining a high-forced draft. It is not a great advantage that it should be so capable, as in the course of their ordinary use in time of war no very great advantage could accrue from this ability. They could be depended upon to burn only 25 lbs. of coal per sq. ft. of grate surface, this figure rising perhaps, in emergencies, for a short time to 30 or even 35 lbs. Such rates of combustion are, however, obtained with very moderate forced draft. It is fortunate that this quality must not be insisted upon. The comparatively direct and unobstructed course of the gases of combustion in most types of water-tube boilers renders them uneconomical with high-forced draft.

An increase in the space on board ship devoted to machinery, above the large amount already so allotted, must be avoided. Inasmuch as the grate surface of the new boilers must be greater for the same power developed at the engines, than that in the type of boilers now used, there would naturally be an increase in the boiler-room space required. This must be avoided; and this can only be done by increasing the ratio of grate surface to floor space occupied above that in cylindrical boilers. This ratio must be a large one, and the larger the better.

Considering the crew a ship is sure to have in time of war, and the fact that frequently the water tenders will be new to the ship, and, possibly, even to the type of boiler used, the boilers must not be complex. The number of attachments must be as small as possible to minimize the work of these busy men.

No great efficiency in firing must be required to attain a good efficiency of the boiler. This follows from the fact that the firemen in the navy in time of war are not equal to doing any particularly good firing. In time of war, locomotive and stationary boiler firemen are as frequently met in the fire-rooms of our ships as are regular trained sea-going men.

The fact that no great efficiency in firing must be expected or required, means that the complete combustion of the fuel must not be attempted in one chamber above the fire. There are sure to be holes in this fire. It will not be the same thickness in one place as in another and the coal will not lie evenly over the grate. At some point, then, beyond which an opportunity for the economical extraction of the heat from the furnace gases is afforded, the gases of combustion must be thoroughly mixed and a combustion chamber furnished.

The care of the boiler while steaming must not be attended with any great difficulty. The water level must be steady. This requires a large area of cross section of the boiler at the water level and in general requires a large amount of contained water in the boiler. This amount of water must not, however, be so great as to interfere with the ability of the boiler to furnish steam quickly from a cold condition.

The parts of the boiler must be afforded a free expansion to make the quick raising of heavy fires under a cold boiler possible without any danger of causing leaks. For the same reason, a good, free circulation of the water in the boiler must be assured. As it is not possible to entirely prevent salt water in the boilers, they must be capable of use with salt water, and the interior must be accessible for cleaning. It must be possible to remove salt and other scale from the water side of the heating surfaces. The tubes must therefore be straight tubes and not of very small diameter. Any attempt to disprove the foregoing by statements that in certain types of boilers there will be no scale deposited upon the heating surfaces that are the most exposed to the heat of the fire must be viewed with doubt. The facility of repairs of the straight-tubed boilers over those that are supplied with bent or curved tubes would also call for the use of straight tubes.

The above conclusions are direct deductions from actual war experience. They must be satisfied to satisfy real war conditions.

If the reasoning has been correct from effect to cause, these are requirements that it is absolutely essential should be fulfilled to secure a proper efficiency of our war ships. They form only a part of the requirements of good water-tube boilers, but an attempt has been made only to point out certain particulars of design that are required for efficiency, as determined by the experience of this war. There are many other lessons to be drawn from the war with Spain, but the necessity for the use of water-tube boilers is the great lesson to the engineer. To know that certain qualities of this type of boiler must be obtained to insure satisfaction, is also interesting. To have a successful and satisfactory water-tube boiler, we must have a boiler that is simple, economical under the ordinary conditions of use, with as few joints as possible. It must be accessible for repairs and cleaning. It must have large grates, not long grates, but grates that are short so as to be easily worked, and that gain area by an increase in the total width.

There have been experiments with water-tube boilers for years. There is an infinite variety of this general type of boiler. They have tubes of all shapes and sizes placed at all angles. These tubes are connected with many types of steam and water drums, placed some within and some without the boiler proper. These boilers are supplied with feed heaters, air heaters, and all sorts of economizers. But the boiler that we want, the boiler that we must have, has certain fixed requirements of design. Many of the types of water-tube boilers fail at once to satisfy those requirements. Is there one that will satisfy them all? If there is such a boiler, which one is it? If no such boiler yet exists, what modifications must be made in that type of water-tube boiler that comes nearest to satisfying the requirements to make it satisfactory now and hereafter? For the sake of uniform design, some one type must be found and adhered to.

NOTES FROM RECENT WATER-WORKS REPORTS.

Boston, Mass.—Some very suggestive figures regarding metered water in Boston are given in the last report of Mr. John R. Murphy, Water Commissioner. The number of bakeries, bath-houses and other classes of premises supplied through meters is given, together with the total quantity of water supplied to and total receipts from each class. During the year ending Jan. 31, 1897, 765,-209,000 cu. ft. of water was supplied through 4,651 meters, and yielded a revenue of $923,350. This was at the rate of $1.21 per 1,000 cu. ft., or a little over 16 cts. per 1,000 gallons. The metered consumption averaged 2,094,000 cu. ft., or about 15,-700,000 gallons per day. Each meter indicated an average of 165,000 cu. ft. a year, which is 452 cu. ft., or about 3,380 gallons a day. The metered water was about 22% of the total consumption for the year, and the revenue from metered water was 35% of the total revenue, no allowance being made for the fact that the total consumption includes water furnished for public purposes without charge.

Of 1,600 defective fixtures, on metered services, found during the year by the waste detection inspectors, 959 were ball-cocks and valves; 521 were sink, hopper, bowl and bath faucets; and 120 were burst service pipes. Mr. J. H. Caldwell is General Superintendent of the Income Division, under which comes the supervision of meters. The Distribution Division, of which Mr. Hugh McNulty is General Superintendent, inspected 47,778 premises for waste during the year, and discovered 9,211 defective fixtures. The number of leaks and stoppages during the year was 2,781, of which 696 were on pipe 4 ins. or more in diameter, and 2,085 on pipe less than 4 ins. in diameter.

The study of electrolysis is continued from year to year by Stone & Webster, of Boston. From their latest report to the city it appears that during the past three years the Boston Elevated Ry. Co. has used the following amounts of copper wire to increase the efficiency of its return circuit:

1895	664,000 lbs.
1896	902,000 "
1897	1,370,000 "
Total	2,916,000 lbs.

The amount used in 1897 was 4,680 lbs. per mile of track. At 15 cts. per lb. the wire used in 1897 would cost about $200,000 for material alone. The copper is in the form of 500,000 circular mil. cables. The electrical conditions of piping in nearly all sections of the city indicated less liability to corrosion in 1897 than in 1896.

Of a total of $10,188 for filter maintenance and operation at Lawrence, Mass., in 1897, $2,323 was expended for cleaning off ice and snow, all but $102 of this being for labor. The filter area is 2¼ acres and is not covered. For washing 2,898 cu. yds. of sand, 1,153,404 cu. ft. of water were used, or about 400 cu. ft. per yard. The average daily consumption of water was 2,848,000 gallons. The operating expenses were nearly $10 per 1,000,000 gallons filtered, more than $2 of which was for removing ice and snow. The following detailed expense account suggests the idea that cheaper methods might be employed for some of the work:

Sanding and scraping	$2,912
Cleaning off ice and snow	2,323
Conveying sand to and from filter	2,718
General	940
Washing and screening sand	1,294
Total	$10,187

By an extensive use of meters the water consumption is being decreased from year to year. Mr. A. H. Salisbury is Superintendent of the Lawrence Water-Works.

All the water used at Woonsocket, R. I., passes through meters, except that consumed at fires. Of a total consumption of 271,237,000 gallons in 1896-97, there was unaccounted for 58,431,000 gallons, or 21.5% of the total. Only a small part of this could have been used at fires, indicating heavy losses of water at some point. These figures add to the surprise caused by the low per capita water consumption in Woonsocket, which was only 26 gallons per inhabitant, 28 per consumer, and 380 per tap. The estimated population actually supplied is 26,000, and the total population is placed at 28,500. Mr. Byron I. Cook is Superintendent.

The last report of Mr. Emil Kuichling, M. Am. Soc. C. E., Chief Engineer of the Water-Works of Rochester, N. H., contains the result of gagings of both the old and new conduits. The old conduit is partly of cast and partly of wrought iron, and the new one is of steel.

Manhole heads provided with lead seats, to prevent rattling, were used in Newark in 1897 on all new work. Mr. M. R. Sherrerd, M. Am. Soc. C. E., is Engineer and Superintendent of the Water Department.

In the last report of the Philadelphia Bureau of Water, of which Mr. John C. Trautwine, Jr., Assoc. Am. Soc. C. E., is Chief, is a large table giving the results of some extensive water tests. These tests are included in the sub-report of Mr. Allen J. Fuller, Assistant in Charge of Distribution. The tests were for accuracy and durability, and are reported in detail. The results are not summarized. Tests of some Venturi and Pitot meters are also given in the report.

At Richmond, Va., when introducing meters on old services, it is customary to set the meter a month in advance of the date on which the rental is to begin to be computed by meter measurement, instead of by fixture charges. If the consumption appears to be excessive the consumer is notified in order that he may reduce it by repairs or otherwise before the meter charges begin. One private residence, with only one faucet and a water-closet, was found to be using 145,000 gallons of water per month, for which the owner was paying only 67 cts., or less than ½ ct. per 1,000 gallons. After the meter was placed the consumption fell to 2,000 gallons a month. Mr. Chas. E. Bolling is Superintendent.

A study of the permanency of the artesian wells from which the water supply of Memphis, Tenn., is drawn, was recently made by Mr. John Lundie, of Chicago, and is included in a report on the water-works made to the city council of Memphis. Mr. Lundie concludes, after the presentation of numerous observations, "that the supply is inexhaustible, and that it is limited only as the supply from any spring or river has its natural limitations."

Some interesting text and illustrations descriptive of the new water-works of Duluth, Minn., are given in the last annual report of Mr. Thos. F. McGilvray, City Engineer. These works were described in our issue of May 5, 1898.

Some interesting information regarding the temperature of the water of Lake Michigan, at Milwaukee, as drawn from the new intake, 46 ft. below the surface and about 8,000 ft. from the shore, are given by Mr. Geo. H. Benzenberg, M. Am. Soc. C. E., City Engineer, in his report for 1897, as follows:

During July and August, 1896, some very notable changes in the temperature of the water taken from the new intake were observed, and as the supply is taken from the lake at a depth of 46 ft. below the surface, or below the range of any wave-action, there was no apparent cause for the fluctuation at that period of the year. In order to ascertain whether any displacement of the water at that depth was due to surface influences, hourly observations and record were kept of the temperature of the air and of the water coming from the new intake, as well as of the wind directions. The observations were made at the end of every hour for a period of 13 months, and then plotted, but no definite relations seem to exist between the variations of temperature at the above depth and the conditions at the surface. The sudden changes in temperature of the water occur only in June and principally in July and August. During the months of October and November there is a uniform and steady decline of from 6 to 7° per month, without more than 1° variation; during December and January, there is a similar decline of 3° per month, and during February a drop of 1°, reaching the minimum temperature of 34° near the end of the month. During March there is a steady and uniform rise of 2°, and during April one of 6°, May 4°, and in June a rise of 3°, with a sudden increase of 8° in a few hours, and a corresponding drop in a shorter time. During July there is not much of a change except the numerous sudden variations, namely, a change of temperature from 45 to 64° in four hours' time, and a drop eight hours later from 64 to 55° in the space of an hour, and after some days another drop down to 47° in a period of seven hours, then in the next 24 hours a change from 47 to 56° in a period of seven hours, from 56 to 50° in two hours, from 50 to 62° in five hours, and a drop from 62 to 48° in seven hours. Later in the month another change from 48 to 65° in eight hours and a corresponding drop from 67 to 55°. In August similar sudden changes were observed, covering a greater range of temperature, some changes of 20° taking place in ten hours, and of 16° in five hours, while in September there was a gradual rise of temperature of about 5° without any fluctuations. There are evidently currents along the lake bottom influenced by some cause not yet revealed. With strong wind from the east or northeast, it would be natural to expect that the undertow would produce an increase in the temperature of the water taken in at the submerged cribs, and that strong westerly winds would have the opposite effect, but the observations do not confirm these expectations into a rule, nor do barometric pressures seem to have any connection with these fluctuations. If the changes were due to gravity, they would occur in October, instead of during the warmest months of the year.

These observations will be repeated during the summer months with a view of establishing the period of maximum changes.

A COLLAPSIBLE CENTER FOR SEWER ARCHES.

The accompanying view, Fig. 1, illustrates a form of collapsible center used with considerable success in the construction of an extensive system of sewers in the suburbs of Calcutta, India. These centers are of different sizes, the one shown being for a 2-ft. brick sewer, but all are constructed in the same manner. Briefly, they consist of a central shaft, Fig. 2, (A) having a right hand screw thread cut upon it from one end to the center and a left hand thread from the other end to the center. Suitable hand wheels (B) are mounted upon the ends. This screw is mounted upon a framing, which also supports four broad rollers (C), used in shifting the position of the apparatus. On the screw are several nuts (N), each provided with two vertical arms (V, V) and two horizontal arms (H. H). The outer ends of the upper and lower arms are hinged to channel irons (I, I), each pair forming a toggle with the nuts forming the center. This arrangement permits the channels to be forced apart or closed up like a parallel ruler, according as the central screw is turned one way or the other.

Securely hinged to the top channel are the two side plates (P, P) bent to the right curvature and braced with small angle irons. The horizontal-hinged arms attached to the nuts, already mentioned, are also attached to the loose edges of these wings or side plates, and are forced apart at the same time the channels spread.

In operation, the lower half of the sewer is built of brick or concrete always in advance of the arch, Fig. 1. The center is rolled into place and the hand wheel turned until the channels and sideplates have expanded to the proper size, and the rollers are lifted free of the bottom, the weight resting upon the lower channel. The arch is then built in the usual way, and, when sufficiently set, the center is contracted by turning the screw in the reverse direction until the center is free and the rollers are in contact with the bottom of the drain when the apparatus is run ahead another length.

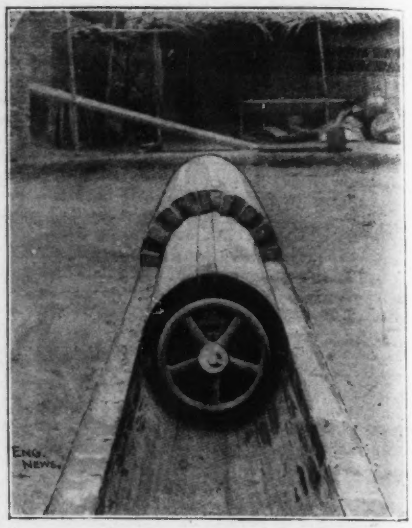


Fig. 1.—A Collapsible Center for Sewer Construction. Burns & Co., Ltd., Calcutta, India, Makers.

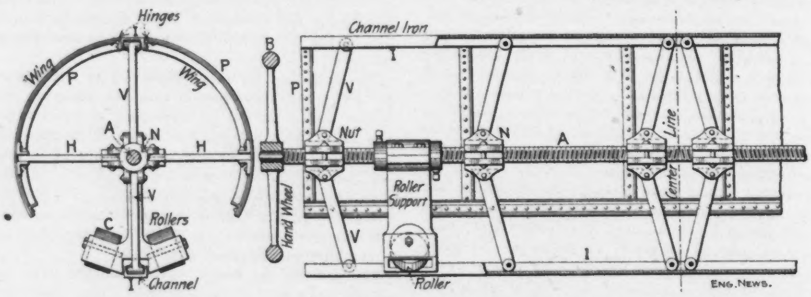


FIG. 2.—SKETCH SHOWING PRINCIPLE OF THE "ROBERTS COLLAPSIBLE CENTER FOR SEWERS.

Referring to the advantages of this device the "India and Eastern Engineer," (Sept., 1898), from which we have reproduced Fig. 1, says:

The advantages of these centers over wooden centers are many. They can be easily run in and out of the drain. There is no adjusting needed, as the center adjusts itself, and the drain must be the same size throughout and must be the required shape. There is a great saving in cleaning the sewers, as no bricks or wedges are required, and there are therefore no obstructions. A great saving in time is effected, as these centers can be removed and fixed in another place in a few minutes.

This appliance is made by Messrs. Burns & Co., Ltd., Hourah Iron Works, Calcutta, India, in a variety of shapes and sizes to suit requirements. The device seems to offer an opportunity for some American maker of contractors' machinery to add a useful specialty to his list.

LOW WATER MEASUREMENTS IN THE STATE OF CALIFORNIA DURING THE SUMMER OF 1898.

By J. B. Lippincott.*

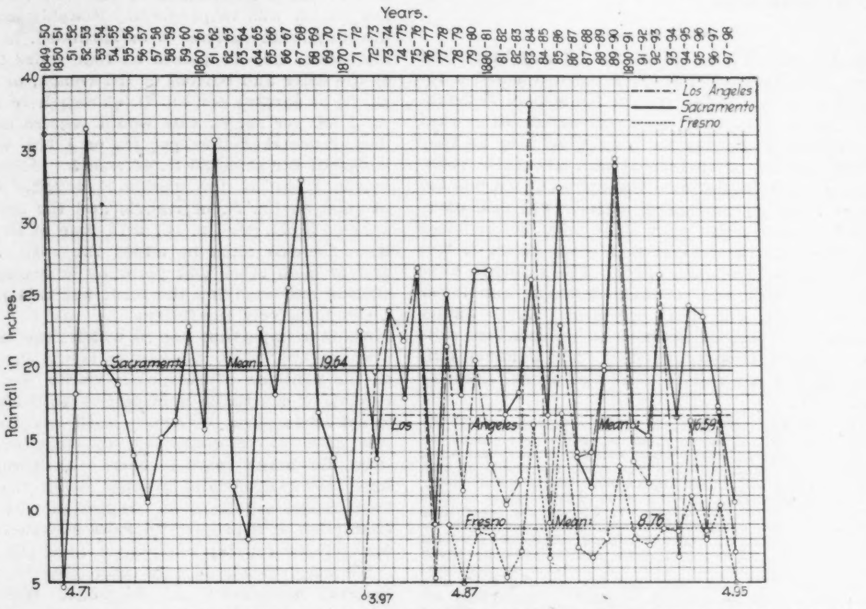
In an arid country the rainfall and stream flow is watched with particular interest. The stream bears much the same relation to the land that an artery in the human body bears to the man. When the supply is either defective or insufficient the entire system of the patient is in a condition of depression.

California during the past season passed through a condition of extreme drought, as will be seen by referring to the accompanying diagram of annual rainfall for a number of years past at Los Angeles, Sacramento and Fresno. Sacramento is in the southern end of the Sacramento Valley, Fresno in the central part of the San Joaquin, and Los Angeles in the southern end of the State. In

*Hydrographer U.S. Geological Survey, Los Angeles, Cal.

the rainfall diagram the year is considered as divided at the first of September, which is the approximate culmination of the dry season.

It will be observed that the seasonal rain during the winter of 1897-98 was relatively very low at each of the above stations. At Sacramento the past year of drought was preceded by a dry year, while at Fresno during the past eight seasons but two have been above the mean, and at Los Angeles only one has substantially exceeded its average rain, and three have been extremely low in precipitation. At the latter place the past group of dry years have probably been more severe in drought than any other known group, with the possible exception of that culminating in 1882-83.



SEASONAL RAINFALL AT LOS ANGELES, 1871-98; SACRAMENTO, 1849-98; AND FRESNO, 1877-98.

This being the condition in California, the Geological Survey has recognized the great value of records of stream flow during the period of lowest depression of the streams, and has directed a series of measurements of the canals and rivers of this State during the months of July, August and September, 1898. This information, it is believed, is of value not only to the irrigator, but also to persons who have, or contemplate, power development, as well as to many of the mining districts where water is essential for the washing of their products. There is given herewith a table which is a partial summary of the work that has been done under the general direction of Mr. F. H. Newell, Hydrographer of the United States Geological Survey, by the writer of this article, who is the resident hydrographer for the State of California, assisted particularly by Mr. F. H. Olmsted, of Los Angeles. In addition to these detailed measurements, daily records of discharge have been kept during this summer on ten typical California streams, and many minor canal measurements have been made.

Measurements of Low Water Stage in California Rivers During June, July, August, September and October, 1898, by the United States Geological Survey.

Date.	Locality.	Discharge, cu.ft. pr sec.
	Sacramento River.	
June 2.	Jelly's Ferry	9,048.00
Sept. 13.	Jelly's Ferry	4,152.00
	Stanislaus River.	
June 1.	Oakdale	911.50
June 1.	Stanislaus & San Joaquin Canal	72.35
July 29.	Oakdale	72.80
July 29.	Stanislaus & San Joaquin Canal at Knight's Ferry	42.00
Oct. 6.	Oakdale	49.60
Oct. 6.	Stanislaus & San Joaquin Canal	32.70
	Tuolumne River.	
July 30.	Lagrange	103.20
July 30.	Mining company's ditch	24.00
Oct. 7.	Lagrange	82.70
Oct. 7.	Mining ditch	24.00
Oct. 7.	Turlock flume	30.00
	Total flow	136.70
	San Joaquin River.	
July 28.	Herndon	611.00
Sept. 2.	Herndon	328.00
	Kings River.	
July 25.	Kingsburg R. R. branch	305.00
July 27.	Red Mountain	503.00
Aug. 30.	Kingsburg R. R. branch	94.10
Aug. 31.	Red Mountain	243.80
Aug. 31.	Church ditch, check near Trimmin spring road	164.30
	Kaweah River.	
Sept. 1.	½-mile above Power Co.'s headworks	35.30
Sept. 1.	Iron bridge	17.90
Sept. 1.	South fork Kaweah at Junction	Dry.
Sept. 1.	North fork Kaweah at Junction	0.30
	Tule River.	
Sept. 1.	Headworks Pioneer ditch (estimated)	6.00
	American River.	
Oct. 7.	North and middle fork at head of north fork ditch	16.00
Sept. 7.	Folsome	34.50
	Yuba River.	
Oct. 7.	Dry except for stored water	.....
	Lytle Creek.	
June 10.	Rialto Canal Ang.-Amer. Caniagre Co. Division	10.73
	City Creek.	
June 11.	Headworks in canyon	3.03
Sept. 9.	Headworks in canyon	0.07
	Plunge Creek.	
June 12.	Headworks	2.26
Sept. 9.	(Estimated)	0.20
	Santa Ana River.	
June 12.	Total at mouth of canyon	39.06
July 23.	" " "	47.56
Oct. 18.	" " "	22.78
June 19.	Narrows 4 miles below Riverside	47.63
June 21.	"M" River in narrows 2 miles below Rincon	79.81
Sept. 8.	Total river at mouth of canyon	36.67
Aug. 28.	River in narrows below Riverside	39.05
Aug. 28.	River in Rincon Narrows	66.82
	Mill Creek.	
June 12.	Grafton Canal; total flow of creek	18.10
July 23.	Total flow, Crafton Canal of creek weir	11.82
Sept. 8.	Crafton Canal; total flow of creek	13.07
	Los Angeles River.	
Aug. 15.	Bridge No. 2 at narrows	38.74
	San Gabriel River.	
July 3.	Total flow at Puente Narrows	61.63
June 21.	Headworks in canyon weir	13.21
Aug. 31.	Total flow at Puente Narrows	52.60
Aug. 16.	Headworks weir in canyon	5.16
Aug. 23.	Headworks weir in canyon	8.42
Aug. 23.	Mouth east fork	7.11
Aug. 23.	Mouth west fork	2.67
	Santa Clara River.	
June 18.	Canulos Ranch	25.74
Aug. 9.	Flume ½-mile above San Francisquito Creek	10.83
	Kern River.	
July 10.	South fork, 700 ft. above junction	12.94
	South fork, near old engineers' camp	17.85
to	South fork Sec. 6T22S., R36E., M.D.N.	10.05
	South fork Monache Meadows	5.31
July 17.	North fork, near junction	330.50
Aug. 29.	First point of measurement, Bakersfield	115.02
	San Antonio River.	
July 2.	In canyon	7.59
Aug. 26.	In canyon	10.01
	Whitewater River.	
Sept. 7.	Above Palm Valley Water Co. h'dw'rks	9.35
	Sespe River.	
Aug. 11.	Division point	2.46
	Piru Creek.	
Aug. 11.	French house	0.92
Aug. 11.	San Francisquito River	2.07
Aug. 11.	Little Tejunga River	0.05
Aug. 26.	Cucamonga River	1.04

TESTS OF THE EFFICIENCY OF FLUSH TANKS FOR SMALL SEWERS, WASHINGTON, D. C.

In a paper read before the American Society of Municipal Improvements, at its convention at Washington, D. C., Oct. 26-28, 1898, Mr. Asa E. Phillips, Assistant Engineer, Sewer Department, Washington, D. C., described a number of interesting experiments carried out by him to determine the actual effect of flush tank discharges upon sewers of small diameter under different conditions of discharge, grade of sewer, etc. These tests were all made on Washington sewers, the flush tanks being those in actual use and having no special preparation for the tests. Briefly abstracted, the conditions and results of the tests were as follows:

Park St. Sewer.—This sewer was 12 ins. in diameter and 1,870 ft. long, with a uniform grade of 0.0075%. The preliminary examination showed slightly unfavorable conditions to exist, such as a somewhat uneven grade and rough joints in places. The tank had a capacity of 84 cu. ft. or about 630 gallons, and it discharged through an 8-in. siphon in the mean time of 42 secs. No attempt was made to determine the velocity at the point of discharge, but the figures given would indicate an approximate mean velocity of 6 ft. per second. Observations of the discharge or flush were taken simultaneously at all the manholes, and the depths of flow were recorded at intervals of 15 secs. or less. The figures, Table I., show how well the depth of flow was maintained for long distances. At 1,000 ft. from the tank the flush is very efficient, and at a distance of nearly 2,000 ft. it appears to be still quite effective. This large radius of effect is doubtless due to the volume of water, as published data for smaller discharges indicate that a tank of one-half this capacity would have a greatly diminished influence.

Connecticut Ave. Sewer.—The series of records taken on this sewer is of interest as showing the effect produced on a varying and decreasing gradient. The sewer was 613 ft. long and 12 ins. in diameter, with the grades shown in Table II. The capacity of the tank was 82 cu. ft., or about 615 gallons, and the mean time discharge was 45 secs. The points to be observed are the diminishing velocity and enlarged area of the discharge wave, as it progresses.

Chapin St. Sewer.—This sewer is 12 ins. in diameter and has a varying but increasing gradient as shown by Table III. The tank has a capacity of 83 cu. ft., or about 620 gallons, with a mean time of discharge of 48 secs. The points which are to be noticed from the table are the rapid run off and greatly reduced area of the flush wave toward the lower end.

Thirty-second St. Sewer.—This sewer is 12 ins. in diameter, and has a nearly uniform steep grade as shown by Table IV. The capacity of the tank was 84 cu. ft. or about 630 gallons, and the mean time of discharge is 45 secs. The table shows the rapid velocity and nearly uniform depth maintained by the discharge wave, giving it an almost piston-like effect.

TABLE I.—Showing Depth and Duration of Flushtank Discharge on Park St. Sewer.

Manholes.	Distance from tank, ft.	Mean normal depth, ins.	Maximum depth of flush, ins.	Duration of maximum effect.
1	200	¾	7¾	1 min. 0 secs.
2	382	⅞	7¼	1 " 15 "
3	572	1	6¼	1 " 45 "
4	738	1¼	5⅝	2 mins. 0 "
5	948	1¼	5	2 " 15 "
6	1,132	...	...	0 " 0 "
7	1,332	1⅜	4½	2 " 45 "
8	1,486	1½	4	3 " 0 "
9	1,688	1¾	3½	3 " 45 "
10	1,869	1¾	3¼	3 " 45 "

TABLE II.—Showing Grade of Bottom and Depth and Duration of Flushtank Discharge; Connecticut Ave. Sewer.

Manholes.	Grade.	Dist. from tank, ft.	Mean normal depth, ins.	Max. depth of flush, ins.	Duration of maximum effect.
1	1%	175	⅞	5½	1 min. 15 secs.
2	1%	325	1¼	5¼	1 " 30 "
3	0.4%	473	1½	5¼	3 mins. 0 "
4	1%	613	1	3½	3 " 0 "

TABLE III.—Showing Grade of Bottom and Depth and Duration of Flushtank Discharge; Chapin St. Sewer.

Manholes.	Grade.	Dist. from tank, ft.	Mean normal depth, ins.	Max. depth of flush, ins.	Duration of maximum effect.
1	1%	190	½	6½	1 min. 15 secs.
2	2%	350	⅝	4¾	1 " 0 "
3	5.6%	490	¾	3½	1 " 0 "
4	9%	705	½	3	1 " 0 "

TABLE IV.—Showing Grade of Bottom and Depth and Duration of Flushtank Discharge; Thirty-Second St. Sewer.

Manholes.	Grade.	Dist. from tank, ft.	Mean normal depth, ins.	Max. depth of flush, ins.	Duration of maximum effect.
1	4%	75	⅛	4½	1 min. 0 secs.
2	4%	265	¼	5	1 " 0 "
3	4.1%	485	¾	5⅛	1 " 0 "
4	5%	725	1	5	1 " 0 "

THE $100,000 WARING FUND has been raised by the Chamber of Commerce and about 90% of it was subscribed by the members of the Chamber. In all there were [illegible] subscribers to the fund.

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.
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ALFRED E. KORNFELD, New York, F. A. PECKHAM, Chicago, S. B. READ, Boston, } ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 299 DEVONSHIRE ST.
LONDON OFFICE, EFFINGHAM HOUSE, ARUNDEL ST., STRAND.

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.

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The ghost of that very dead scheme to parallel the ocean by a ship canal from New York to Philadelphia, was held up to public view at a recent meeting of the Commission which is engaged in hunting up reasons for the failing off in New York's commerce. The exhibitors were Thos. Martindale, Esq., Vice-President of the one-time Ship Canal Commission, of Philadelphia, and Prof. L. M. Haupt, its engineer. Mr. Martindale, according to several newspaper reports, argued that the "hand of Providence" had obviously designed that the two cities should be connected by a ship canal, since a natural topographical depression existed over the proposed route. He failed to explain, however, why the alleged providential intention was not made more manifest by completing the work as a natural waterway in the first instance, without man's intervention.

Prof. Haupt brought up his old-time argument that the railways were buying up the canals to stop their competition, and that the railway companies injured their own interests by so doing, since they could only make a profit from high-class short-haul traffic, and it would be to their advantage to turn over the traffic in bulk freights to the waterways.

It is strange, indeed, how blind railway managers are to this piece of financial wisdom. Here is the Delaware, Lackawanna & Western R. R., for example. In its last fiscal year it made a profit of $102,922 from its passenger traffic; it lost $509,774 on its freight traffic in general merchandise, and it made a profit of $6,344,936 from the hauling of coal. Its managers will doubtless be exceedingly interested in Prof. Haupt's dictum, that it is the high-class short-haul traffic which the railways should seek to develop.

We suppose Prof. Haupt would reply to the above that the Lackawanna and the other anthracite carrying roads are charging excessive and exorbitant rates for carrying coal. This is certainly true, but the fact still remains that all the rest of the traffic of the company is handled at little or no profit.

Concerning freight rates on coal, one argument brought forward for the proposed canal is that it would reduce the cost of the coal supply of New York city an average of 50 cts. per ton. But is this quite certain? Philadelphia is not much nearer the anthracite fields than New York. Like New York, she is dependent on rail transportation for her coal supply, and Prof. Haupt himself complained that the railways charged too much for hauling anthracite to Philadelphia. So long as the railways hold a necessary link in the line, they can control the price of coal in New York, no matter how many canals might be built from Philadelphia here.

Meanwhile, it is by no means unlikely that other influences may become operative to compel a reduction of anthracite freight rates to a reasonable figure. The coal operators cared little what the railways charged for freight, so long as they could dispose of their coal and get their price. But of recent years, soft coal competititon has become a rapidly increasing factor. The coal operators have realized that they must either place anthracite in the market at a lower figure or lose a large portion of their trade. The railways have turned a deaf ear to their demands for lower freight rates, and the operators have finally adopted the plan of building an independent railway to the anthracite districts. The January bulletin of the Anthracite Coal Operators' Association says:

> The New York, Wyoming & Western Railroad is the rational outcome of the system of unjust discrimination which the present transporting companies have practiced against the operators. This road is in the hands of, and supported by individual operators, representing probably 20,000,000 tons, of which about 14,000,000 is shipped at the present rate of mining. It will be the controlling element in the future conduct of the trade. Built for cash, and without any excessive bonds or stock; provided with the most modern equipment, and operated on sound business principles, the road will be able to transport freight at a far lower cost than any existing anthracite railroad. Should an attempt be made to demoralize the market, it can make a price and deliver a sufficient quantity to effectually settle all disputes and make the market extremely unprofitable to any who might have tampered with it. Every other means of securing an equitable arrangement between the transporters and operators has been tried and has failed. This step was so radical and involved so many far reaching considerations, that it was set aside time and again in the futile hope that some of the many plans suggested by the controlling interests might be carried out. But now that it has been determined upon, it will be carried forward with that same energy and directness which has characterized the conduct of the operators in their other enterprises, and that it will succeed in obtaining the results desired does not admit of dispute.

In general we place little confidence in projects for railway construction whose avowed purpose it is to parallel and to compete with an existing railway fully able to accommodate the traffic. The almost invariable outcome of such schemes is the consolidation of the competing concerns, and the traffic henceforth has to pay interest on the cost of two roads instead of one. The project of the coal operators, however, is a peculiar one, in that the owners of the road can, if they choose, themselves control the traffic. They will not have to go into the field and cut rates to obtain business for their road, and they should be able to keep the fixed charges on their line down so low that they can do business at less cost than any of their competitors.

A cheap disinfectant, which can be easily prepared and applied, is urgently needed for use in Havana and the other Cuban cities which have recently passed from Spanish to American control, to disinfect the thousands of cesspools, privy vaults, stables and other places of deposit for foul and infectious wastes. It will also be needed for sprinkling earth thrown up from trenches and the sides and bottom of the trenches in the excavations for the sewer system, which is one of the most urgently needed improvements. All things considered, it is probable that no more satisfactory agent can be found than milk of lime. As noted elsewhere in this issue, sanitary regulations recently put in force in Paris to govern work in street excavation require the application of about ½-oz. of sulphate of iron, or copperas, and ⅝-oz. of quicklime, or ordinary unslaked lime, to each square foot of exposed surface needing disinfection. The best available information on disinfectants,* however, indicates that sulphate of iron has less value as a disinfectant than was formerly supposed, and that it would be better to rely upon quicklime alone for such work as that in Havana.

If we assume that 1 oz of unslaked lime per sq. ft. is sufficient for disinfection of earth and trench surfaces, 1 bbl. of lime, or 230 lbs., would disinfect 3,680 sq. ft. of surface.

The Paris regulations apparently contemplate, that in sewer trenching in such filthy soil as that of Havana, the sides and bottom of the trench should be treated as described above, and that the excavated material should also be sprinkled whenever excavation was stopped. This might mean two or three sprinklings of the dirt bank while the trench was in progress. Roughly estimated, the maximum surface to be sprinkled, in trenching work, may be placed at four times the area of the sides and bottom of the trench, or say 100 sq. ft. of surface per lin. ft. of trench 10 ft. deep. At 1 oz. per sq. ft. this would require about 6¼ lbs. of unslaked lime per ft., or 1 bbl. would be sufficient for some 36 ft. of trench. Allowing for waste, 1 bbl. of lime should thoroughly disinfect at least 30 lin. ft. of trench, and the cost would only be 3 cts. per lin. ft., with lime at 90 cts. per bbl. To this must be added the cost of water, and of such labor and plant as is necessary for slaking and applying the lime; but this would be a comparatively small item.

Another important use to which lime can probably be applied to advantage is the disinfection of the contents of cesspools, vaults, etc. These cannot, of course, be immediately abandoned, and in suburban parts of the city their use will doubtless have to be continued, to some extent, at least, for many years to come. A liberal use of lime, however, should greatly lessen the danger from these; especially in connection with the introduction of a proper "odorless excavation" system for the regular removal of their contents.

We may remark in this connection that in the sanitary renovation of Santiago, which Gen. Wood has been carrying on, a liberal use of lime has been one of the chief factors in his marked success. Gen. Greene also made good use of lime to purify the surfaces of the paved streets in Havana, after cleaning off the accumulations of filth. Thus it looks as if the extension of American rule in Cuba may be marked by a trail of whitewash; and we trust it may be emblematic of the moral and political purification which is also to be effected there. Certainly, if we send men like Ludlow and Wood and Black to administer Cuban affairs, there will be no need for an after application of that other kind of whitewash, which has become so well known in connection with political affairs at home.

Comparisons between the number of deaths from typhoid fever in New York and Philadelphia during 1898, made by the Philadelphia "Ledger," are decidedly unfavorably to the Quaker city. This is as would be expected by anyone familiar with the character of the water supply of the two cities. New York has not hesitated to expend money liberally for securing pure water and for protecting its sources of supply from contamination. Philadelphia, years ago, did some good work in the acquiring of lands along the river above the Fairmount water-works intake for park purposes, and in the successful prosecution of at least one offender who was polluting the supply, the decision in this case being a notable one.* But for years past the city has gone slothfully and slovenly on, allowing its water supply to become more and more dangerous. According to the figures given in the "Ledger" the number of typhoid deaths in Philadelphia in 1898 was 639, against only 671 in Greater New York, with two or three times the population. The portion of New York which constituted the city prior to consolidation, and which in 1890 had 1½ times the population of Philadelphia, had but 374 deaths from typhoid in 1898, or a little over half the number in Philadelphia.

*See "Notes on Disinfectants and Disinfection," by A. G. Young, M. D., in the Report of the Maine State Board of Health for 1897.

*See Rafter and Baker's "Sewage Disposal in the United States," p. 98, opinion in Commonwealth of Pennsylvania vs. Soulas.

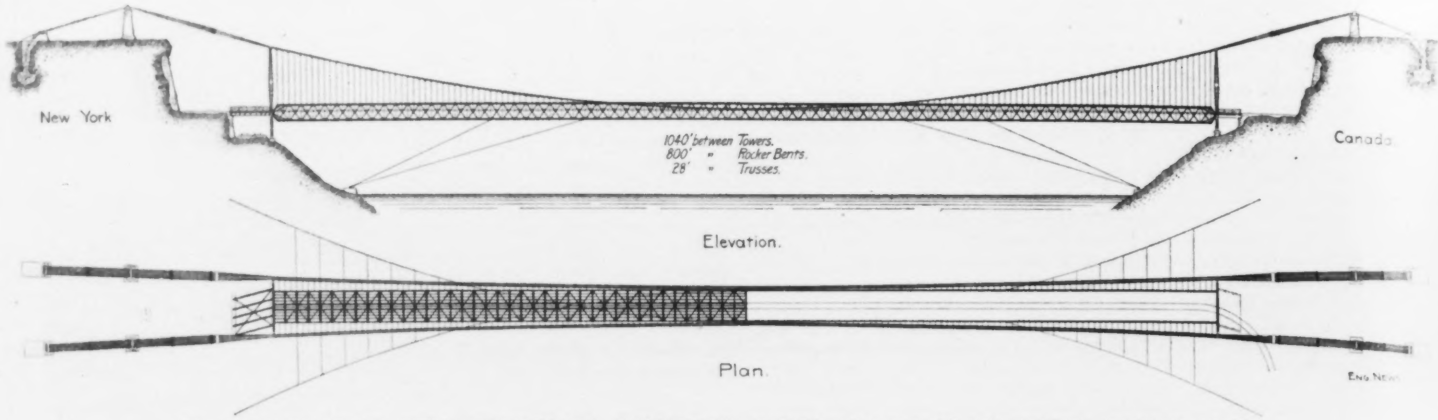


FIG. 1.—NEW 800-FT. SPAN, LEWISTON & QUEENSTON SUSPENSION BRIDGE ACROSS THE NIAGARA RIVER.
R. S. Buck, M. Am. Soc. C. E., Chief Engineer; L. L. Buck, M. Am. Soc. C. E., Consulting Engineer.
New Jersey Steel & Iron Co., Trenton, N. J., Contractors for Superstructure; James Stewart & Co., St. Louis, Mo., Contractors for Substructure

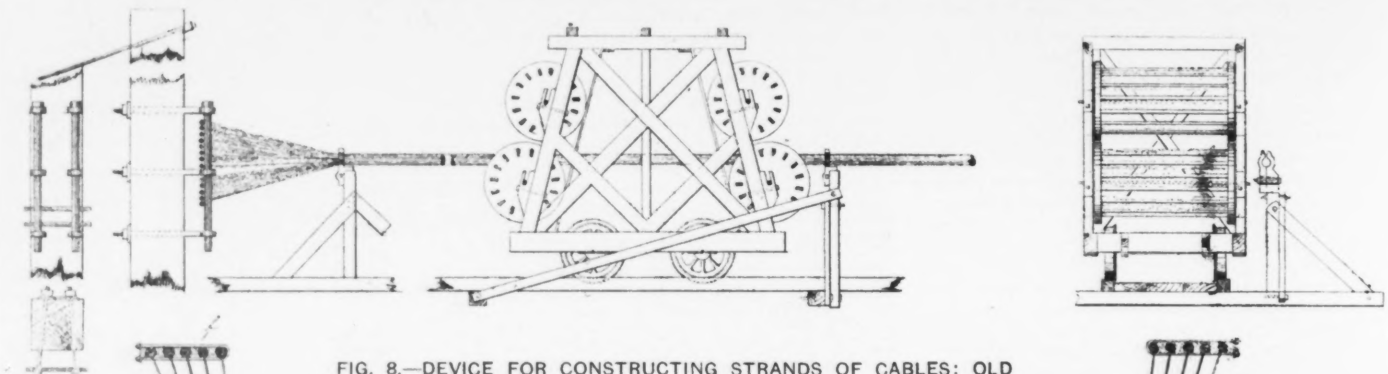


FIG. 8.—DEVICE FOR CONSTRUCTING STRANDS OF CABLES; OLD LEWISTON & QUEENSTON BRIDGE.

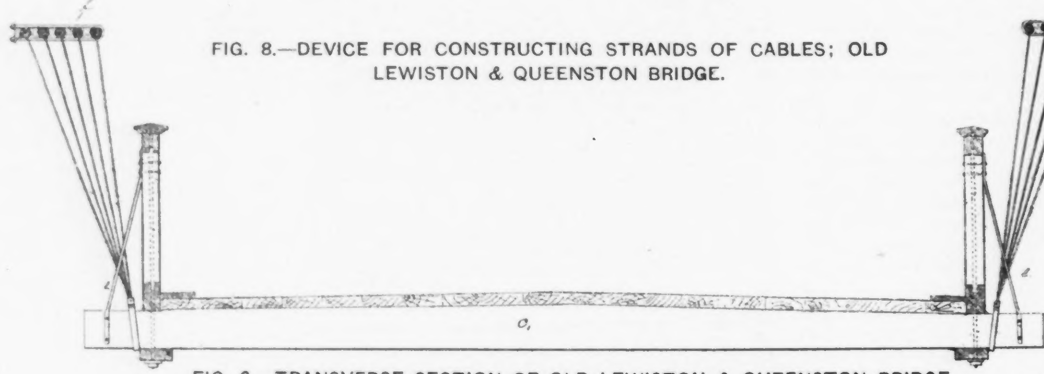


FIG. 6.—TRANSVERSE SECTION OF OLD LEWISTON & QUEENSTON BRIDGE.

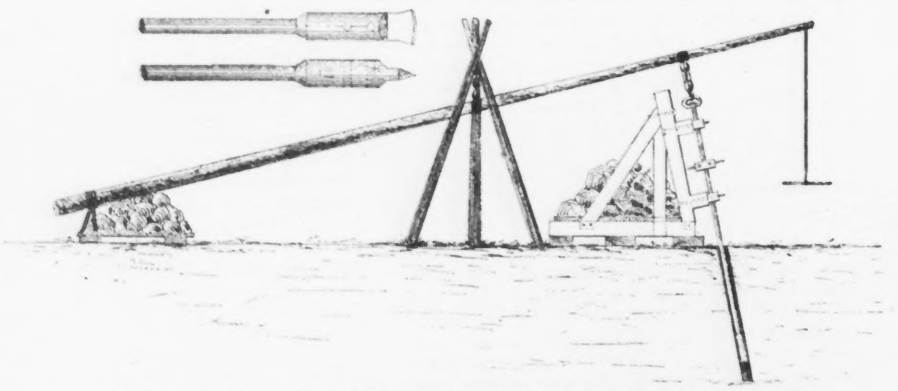


FIG. 5.—DEVICE FOR DRILLING HOLES FOR ANCHORS; OLD LEWISTON & QUEENSTON BRIDGE.

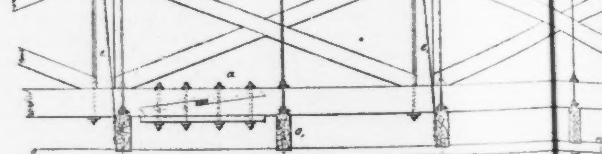


FIG. 7.—STIFFENING TRUSS; OLD LEWISTON & QUEE

THE OLD AND NEW LEWISTON & QUEENSTON SUSPENSION BRIDGES ACROSS THE NIAGARA RIVER.

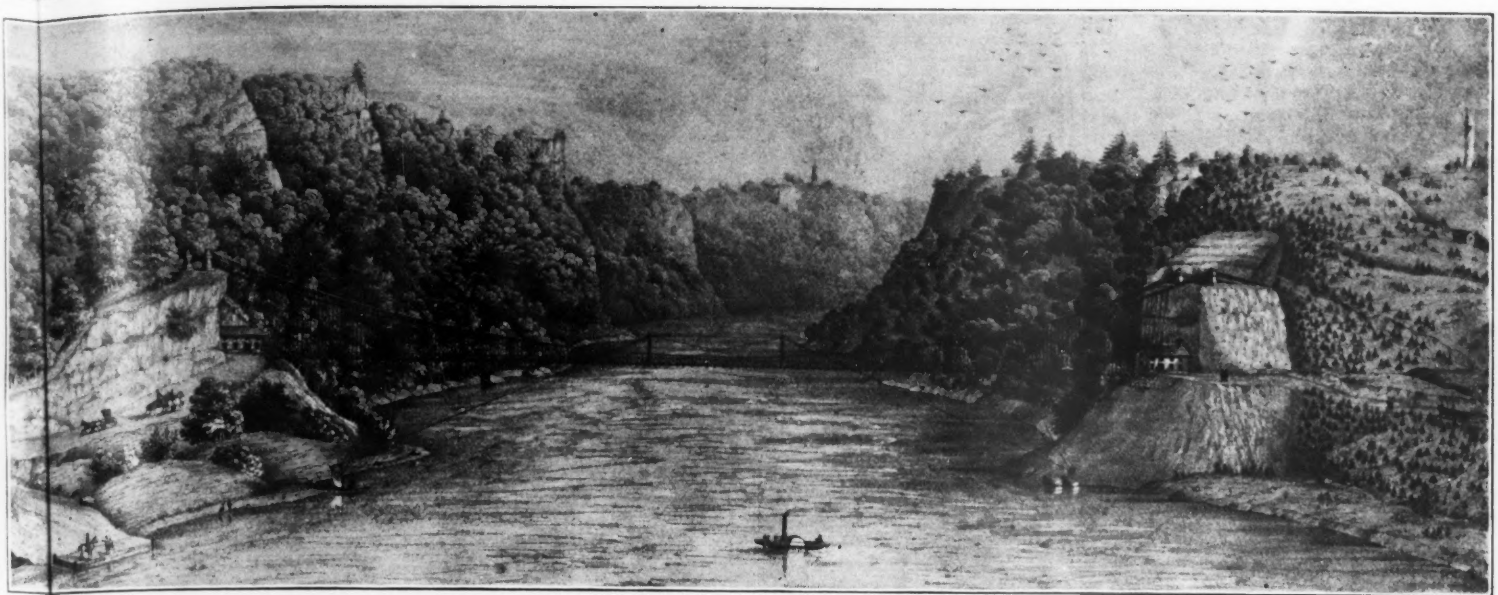


FIG. 2.—VIEW OF OLD LEWISTON & QUEENSTON SUSPENSION BRIDGE BUILT IN 1851.
Capt. Edward W. Serrell, Chief Engineer.
T. L. Griffith, Assistant Engineer.

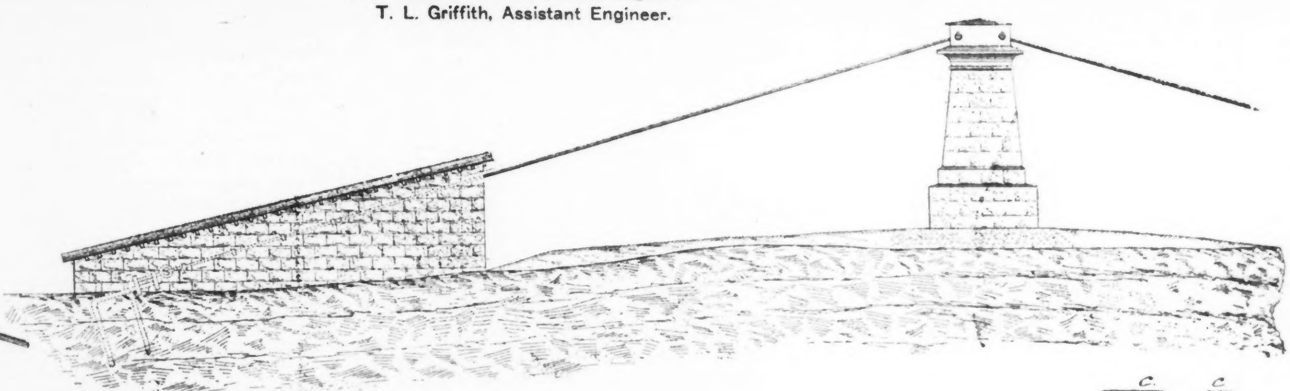
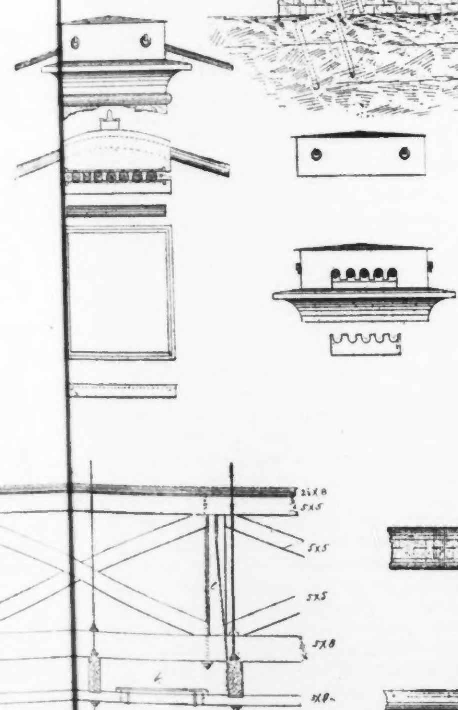


FIG. 3.—ANCHORAGE AND TOWER CONSTRUCTION; OLD LEWISTON & QUEENSTON BRIDGE.



...ISTON & QUEENSTON BRIDGE.

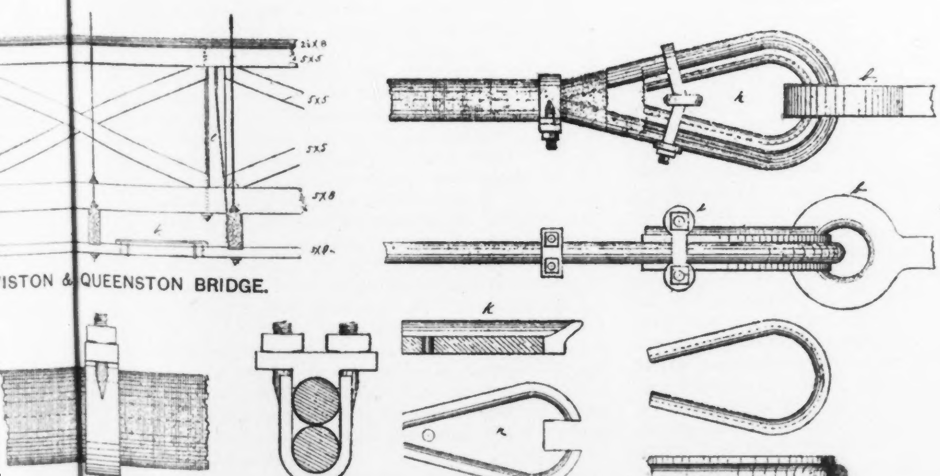
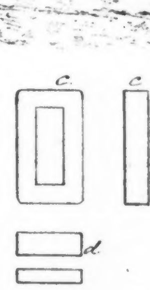


FIG. 4A.—DETAILS OF CABLE CONNECTIONS WITH ANCHORS.



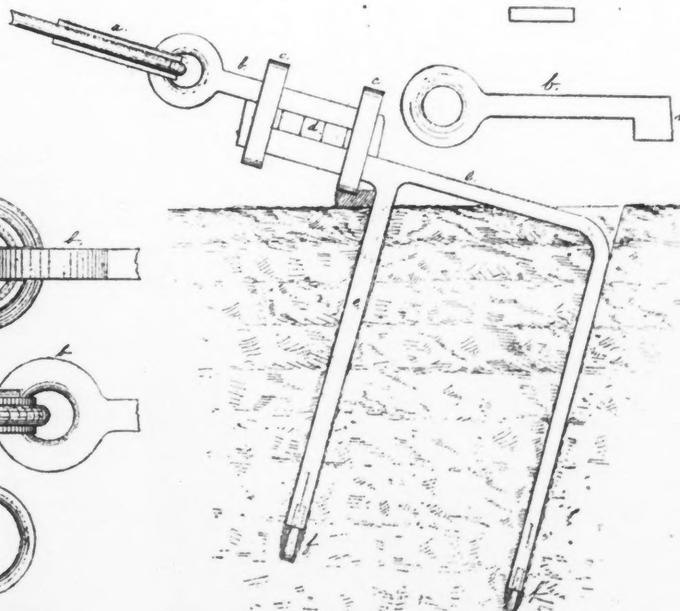


FIG. 4.—ENLARGED DRAWING OF ANCHORS; OLD LEWISTON & QUEENSTON BRIDGE.

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Hundreds of deaths in Philadelphia might be averted yearly if the city councils would do their duty and provide pure water. As long as dollars outweigh deaths there, the "slaughter of the innocents" will go on unchecked.

We commend to the especial attention of every one of our readers interested in the use of asphalt, an article published elsewhere in this issue upon the nature of asphalt mixtures. If the question were asked: Why is an asphalt pavement hard? most engineers would probably reply that it is because the asphalt cement, which is a viscid liquid when the pavement is laid, becomes a solid upon cooling, and sticks together the particles of sand and lime-dust of which the mixture used for street pavement is chiefly composed. But strictly speaking, asphaltum, or asphalt cement, as it is more commonly called, is not a solid at any temperature. It will flow—very slowly, it is true, but to some extent—at all ordinary temperatures. Why, then, does not the mixture used in asphalt paving flow?

The writer of the article referred to discusses this question and reaches the conclusion that the asphalt is held between the particles of sand or lime-dust by capillary attraction; and he illustrates this by the sand of a sea beach which is hard and firm when saturated with water, but is extremely soft when dry. The theory suggested seems extremely plausible, and its practical bearing upon the character of the sand and other aggregates used in making asphalt paving mixtures is evident. It seems not at all improbable that variations in the wearing qualities of asphalt as laid in different cities and by different companies may be due more largely to the variation in the character of the sand grains than to the difference in the quality of the asphalt cement used.

The subject is one on which more definite facts are highly desirable. It is to be hoped that some of the engineering school laboratories may take it up and give it a thorough investigation.

The people of New Orleans will, on Feb. 2, vote upon a $9,000,000 loan for sewerage, drainage and water supply. New Orleans and Baltimore are the only two large cities in this country which are without sanitary sewerage systems. New Orleans has done something for surface drainage, and has further work of great importance under way. Its water-works are very inadequate for the wants of the city, and are controlled by a private company, a minority of the stock of which is owned by the city. A franchise for a sewerage system was granted to a company some six years ago, but the company made a financial failure of its enterprise before accomplishing any work of practical value, and the city has a suit pending to annul the franchise. If the proposed bond issue is voted down next month, new life will doubtless be infused into the private sewerage scheme. It has always been the policy of American, as well as foreign cities, to own and operate their sewerage systems. New Orleans will make a great mistake if it does not seize this opportunity to free itself from the dangers and disadvantages which attend the ownership and control of its sewer system by a private company. It is also the policy and the practice of our largest, and nearly all of our smaller cities, to own and operate their systems of water supply. Private ownership of water-works at New Orleans has been a notable failure, whether it be judged by the poor quality of the water furnished or the small percentage of the inhabitants who use the public supply. The most crying need at New Orleans is an efficient and comprehensive sewerage system, but better water and more users of it, and thorough drainage are also needed. With these three improvements, as Mr. W. C. Flower, Mayor of New Orleans, has recently pointed out in an address to the people favoring the bond issue, the prevalence and the dread of yellow fever would be largely, if not wholly, averted, the health of the city in other respects would be greatly improved, and the whole commercial and business interests would receive an immense impetus.

The Mayor is undoubtedly correct, also, in urging that these improvements should take precedence of expenditures for street paving, another matter in which New Orleans is lamentably deficient. The sanitary advantage of good paving is undoubtedly great, but a pure water supply and thorough sanitary drainage are of still greater importance, and should have the first consideration.

THE DESIGN OF RAILWAY STATIONS.

I.

The passenger stations of American railways have within recent years shown a marked advance in their architectural design and in the accommodation afforded, and these remarks apply not only to the great terminal stations, but to the moderate sized and small stations which are taking the place of older structures. In too many cases, however, the general arrangement is defective in that it does not fully meet the requirements for the convenience of passengers, the handling of crowds, and the general work of the station staff. This is due usually to one of two conditions: either (1) sufficient attention is not given to a study of the service requirements, or (2) these requirements are subordinated to architectural treatment. It may be said from the first, that the design should not be entrusted entirely to an architect, even if he be one of the regular officers of the road. In every case the superintendent, station master, and other officers connected with the operating and traffic department, should be consulted, and due weight should be given to their opinions, recommendations and objections. The general plan, also, should be submitted to and carefully examined by the officers most competent to judge it in its relation to traffic conditions.

Passenger stations may be classed generally under three heads: Head-house, side-house and island stations, according to whether the main building is at the end or the side of the tracks, or between the tracks. Terminal stations are usually of the latter type, but often with a wing on one or both sides, forming an L or U-shaped building, and serving to close the sides of the trainshed. These wings may either be one-story structures for baggage and mail rooms, etc., or may be more pretentious, forming a part of the main building.

Head-house stations forming dead-end terminals are objectionable where through traffic has to be handled, as trains must either be reversed (causing annoyance to the passengers), or must lose time in switching so as to go in and come out with the cars facing the same way. These objections were discussed in our issue of July 10, 1896, in connection with a project for a dead-end terminal at Omaha, Neb., which city is on several through lines between eastern and western points. The troubles incident to such an arrangement have been felt at Philadelphia, Baltimore, etc., and great sums of money have been spent at certain points both in this country and in England in converting terminals into through stations. At most large stations, however, there is a certain amount of suburban and branch line traffic, the trains for which can best be accommodated on stub tracks, thus avoiding the necessity of having such trains standing on the main through tracks.

The Pennsylvania R. R. and Philadelphia & Reading R. R. terminals in Philadelphia, and the Union Station at St. Louis, are examples of the head-house plan, pure and simple, having no wings. The Grand Central Station in New York is an example of the L-shaped plan, the offices of the New York Central R. R. being in the side-house or wing, and those of the New York, New Haven & Hartford R. R. in the head-house. With a side-station it is more difficult to handle large crowds and to keep people off the tracks, and at a terminal it may be necessary to fence off some of the tracks and to provide a wide platform between the building and the tracks, having a part fenced off and affording access to the transverse platform across the ends of the tracks. The Union Station at Chicago is peculiar in that it is a side-house terminal station with through tracks. The trains of the P., Ft. W. & C. Ry., the C., B. & Q. R. R., and the C. & A. R. R. enter and leave at the south end; while those of the P., C., C. & St. L. Ry. and the C., M. & St. P. Ry. enter and leave at the north end. In most side-house stations the building is of considerable length, but in some cases, as at Syracuse, N. Y., it is a short square building. This may depend upon the general design or upon the amount of land available.

Large side-house stations may either have all the accommodation included in one building, or may have a main building for the passenger business, and a separate (and usually less pretentious) building for baggage, express, and mail service. In the new station at Providence, R. I., this separation of the business is carried to an unusual degree, there being five separate buildings in a row. The central building is for the waiting-rooms,, ticket offices, etc., and is flanked by the restaurant and baggage buildings, connected with it by colonnades. Beyond these again, and entirely independent of them, are the office and express buildings. Stations having a large suburban traffic may have buildings on both sides of the track, one of these usually containing only waiting-rooms. In such a case the main building should be on the side at which there is the greatest traffic. The Newark station of the Pennsylvania R. R. is on this plan. In exceptional cases, however, as at Brockton, Mass., there are two regular station buildings, each having ticket offices and full accommodations, but this is an expensive plan in operation as well as in construction.

The island arrangement is not usual for large stations, but the new stations at Nashville, Tenn. and Pittsburg, Pa., will be of this class. The through tracks pass on either side of the building, while trains starting or ending their runs at these points will use stub tracks in a trainshed at one end of the building. In the Nashville station, stub tracks for freight cars will be at the other end of the building, the approach being from a viaduct over the yards, but at Pittsburg there will be a roadway approach at the end. The fine new stations at Dresden and Cologne, in Germany, are also of this class, and have their tracks above the street level, as at Pittsburg. The Cologne station has a great island platform 180 ft. wide, with the building in the middle, through tracks at each side and stub tracks at each end. The Euston terminal station in London is wedge-shaped, having the building between two sets of stub tracks which converge just beyond the station. This wedge-shaped plan is sometimes adopted at junctions, and in fact the Pittsburg station above mentioned may be considered as of this class rather than of the island class.

Union stations are very convenient within certain limits, but the schemes sometimes put forward for immense union stations in very large cities have usually little to recommend them from a practical point of view. In London there have from time to time been projects for a great central station, but it will readily be seen that to combine the main line and suburban traffic of some 15 terminal stations of 10 trunk lines would probably result in hopeless intricacy and confusion. What London really needs, and is in a fair way to secure, is a better system of rapid transit connecting the main railway stations. In Chicago, projects are suggested from time to time which provide for large stations to take the place of some of the six large stations now used by the great number of railways entering the city. At the close of the Columbian Exhibition it was seriously suggested that all the railways should use the great Manufactures Building as a terminal station, abandoning the city terminals and establishing local and city connecting lines.

The upper floors of the station building may be utilized for the railway company's offices, business offices, or for hotel purposes. The office or hotel entrance should be entirely independent of, and as far as possible from, the station entrance, but for the hotel or railway offices a special entrance from the station should be provided. In London and many other large cities in Great Britain, the principal stations, whether terminal or through, have large and handsome buildings specially designed for hotel purposes, the railway companies being more or less interested in the finances and management of the establishment. Such hotel accommodation is very convenient for strangers, and for persons arriving by late trains or leaving by early trains. It seems strange that this practice has never, so far as we can recall, been introduced in this country. One reason that may be suggested is that American railway companies do not look with favor on the outside enterprises, such as hotel accommodation and the collection and delivery of freight, which are extensively undertaken abroad. It may be noted that the Canadian Pacific Ry. has established a hotel at its new east-end or Dalhousie Square terminal station in Montreal, while its older west-end or Windsor Square station contains the general offices of the company.

The rooms on the street level may be rented for shops, stores, etc., and where the tracks are elevated, that portion of the building below the trainshed and platforms may be utilized for baggage and express purposes, or for storage, etc., according to local surroundings. The Philadelphia & Reading R. R. station at Philadelphia has four separate buildings at the street level, below the main floor; (1) the lower floor of the head-house, containing the main entrance, waiting-room, ticket-offices and baggage-room; (2) express office and market restaurant, separated from the head-house by a wide space forming a cabstand, and being an extension of Hunter St.; (3) a market-house; (4) the power-house for the station. As the site selected for this station included two markets, it was decided to establish a new market under the station, with cold storage under the market, so as to reduce the necessity for using ice. This arrangement was, therefore, specially provided for in the design. The basement of the great St. Pancras station (Midland Ry.) in London was designed specially for the beer traffic, and the piers and columns are spaced to allow of the closest possible storage of barrels, a beer barrel being the unit of measurement. The lower floors of many English stations are used for storage purposes, while the arches of the brick approach viaducts are utilized as stables or for storage.

It is hardly within our province to discuss the questions of architectural design, but it may be said that a simple and bold treatment, which will give a conspicuous building of imposing and dignified appearance, is preferable to the mixed style and the profuseness of "ginger-bread" decoration sometimes seen.

In the main plan, the probable growth of traffic should be considered and provided for, even if the complete design is not at first carried out. If extensions are made without any fixed plan, the result is often awkward in appearance and inconvenient for passengers and the general business of the station. The architect or designer, however, is sometimes arbitrarily limited to certain dimensions or arrangements which preclude the possibility of producing a successful design.

A case of this kind may be given as an example. A few years ago the directors of a certain railway authorized the construction of a large station building, to contain the railway company's offices. The architect, therefore, prepared plans for a large and handsome building, but the Board of Directors concluded that it was designed on too large a scale, and would be too expensive. Acting under instructions, therefore, the architect made new plans, reducing dimensions, cutting out some of the rooms, and eliminating an entire wing. For some time past the company has found its office accommodation cramped and restricted, and the addition of a wing has been suggested. This cannot well be done now, however, without interfering with the general design of the present building, and would necessitate some changes in the trainshed and other parts of the station. Under the original conditions, the wisest plan would have been to adhere to the design, but to build the main part of the station at first, leaving the rest to be erected when required. This could probably have been done without much alteration in the original plans, beyond slight changes in the architectural treatment to prevent the first part of the building from appearing incomplete.

In another case, the railway company insisted that an annex to a large station should have a metal roof supported by short-span girders and cast-iron columns, in order to have a cheap construction. Fortunately, proper representations were made as to the inconvenience caused by the columns, and as to the poor appearance of such construction, and the company permitted the use of steel roof trusses carrying a tile roof, in keeping with the design of the main building.

The building should be easy of access, having broad sidewalks and ample entrances, so as to prevent confusion and to facilitate access from the street to the ticket offices or platforms. Large stations should also be set back far enough from the street to allow of a carriageway and cabstand independent of the street, so that passengers' cabs will not interfere with the street traffic, and the passengers will not have to make their way across a crowded sidewalk. At the main entrance the sidewalk should be covered with a glass canopy or roof, supported by bracket trusses or by columns, so as to shelter passengers while going to and from the cabs. In this country, a porte-cochere, or covered carriageway, is frequently provided as an architectural feature, but usually admits but one carriage at a time. A long canopy roof enables a number of carriages to take up and set down passengers at the same time, and this arrangement is, we believe, in use at the new Broad St. station of the Pennsylvania R. R., at Philadelphia, Pa. An alternative plan, which may be adopted where the station building is of necessity carried out to the sidewalk of a busy street, is to provide a circular or rectangular space within the building for the accommodation of cabs. This is done in the north-end union station at Boston. Many large English stations have a carriage roadway through the trainshed, parallel with the principal tracks used by incoming trains, so that passengers find cab accommodation alongside the cars.

The general arrangement of the station and its approaches will depend upon local conditions, such as the amount and nature of the traffic, the proportion of traffic of different classes (main line, suburban, excursion, etc.), the topography, the relative grades and locations of streets and tracks, and the character of the surroundings. The city should, for its own interests, provide good and convenient approaches, and see to it that these are kept clean and in good condition. This applies not only to the actual approaches, but to the main routes between the station and the business part of the city.

As to the interior arrangement of the station, it is impossible to lay down any rules, as the arrangement will of necessity vary in each case according to traffic and local conditions. For a station in the heart of the city, where land is valuable, all accommodation must be concentrated as far as possible, while under other circumstances a much greater area may be available. One of the main ideas in view should be to prevent confusion and unnecessary walking to and fro, by providing ample entrances and direct and convenient routes from the entrances to ticket offices, waiting-rooms, baggage check-rooms, and the platforms. There must also be ample and direct means of exit for passengers from incoming trains, and so arranged that there will be no interference between the streams of passengers to and from the trains. Besides the regular main line and suburban traffic, the possibilities of large holiday and excursion crowds must be considered. Such crowds will best be provided for by ample means of entrance and exit, and by extra ticket windows.

The importance of providing ample accommodation for crowds entering and leaving the station, and for preventing such crowds from interfering with street traffic, seems to be frequently overlooked. A single spacious archway, while architecturally striking and successful, is not a success from a traffic point of view, as the streams of passengers will clash, to their delay and annoyance. Rows of entrances distributed along the building, and in passages between the waiting-rooms and offices, will break up and distribute the crowd, and will also prevent the crowd from disturbing the occupants of the waiting-room. A broad platform across or alongside the tracks, having numerous passages communicating with a broad sidewalk on the outside of the building, will do much to prevent crowding and confusion.

Among the accommodations to be provided may be mentioned the following, the requirements varying with the size and importance of the station: (1) Convenient and commodious entrances and exits; (2) general waiting-room; (3) women's waiting-room and parlor; (4) smoking-room; (5) parcels checking-room; (6) ticket offices; (7) sleeping-car office; (8) telegraph office; (9) toilet-rooms and lavatories; (10) lunch and dining-rooms; (11) information office; (12) news-stand; (13) baggage-room; (14) mail and express rooms; (15) store-rooms. Also porters' or janitor's living apartments, rooms for conductors and trainmen, and quarters for the station staff. At divisional stations there will also be required offices for the superintendent, master mechanic, resident engineer, roadmaster, train dispatcher, yard master, station master, etc. Other accommodations may include a barber shop, boot-black's stand, telephone and messenger offices, and perhaps emigrants' rooms or separate rooms for colored people. At large stations it is well to provide extra accommodations for trainmen and the station staff, in the way of reading-rooms, bath-rooms, etc., to act as a counter-attraction to the saloon.

The architects and designers of American railway stations seem to be possessed with the singular and entirely erroneous idea that the main waiting-room should be the main thoroughfare between the entrance and the platforms. Many such rooms have doors at opposite ends opening upon the sidewalk and platform, forming a good opportunity for through drafts. Then at the sides are the ticket offices, parcels office, news-stand, etc. In this way, persons who are using the waiting-room for its legitimate purpose, are disturbed by the stream of persons pouring through the room, and by the bustle and talk at the ticket windows, etc. A separate and private waiting-room for women is usually provided, but a man who is weary or sick has no place where he can rest in quiet.

With the American system of establishing ticket offices in the hotels and on the business streets, many passengers have no need to go to the ticket office at all. Passengers who have to buy tickets or to wait for trains ought not to be interfered with by the streams of passengers, especially suburban passengers, who go direct to the trains. With the arrangement of gateways in the covered ways between the buildings of the station at Providence, it is expected that 60 to 70 per cent. of the passengers will use these entrances, which effect a direct communication between the approaches and the main platform. This prevents the disturbance of the occupants of the waiting-room (which, of course, has doors opening upon the platform), and also provides for the prompt handling of crowds. Even in stations of medium size, it is well to provide passageways through the building, entirely independent of the offices or rooms.

The wise idea of separating the waiting passengers from those who have to purchase tickets, etc., or who wish to go direct to the trains, has been followed out in some cases. The Milwaukee side-house through station of the Chicago, Milwaukee & St. Paul Ry., and the Park Square (Boston) head-house terminal station of the New York, New Haven & Hartford R. R., are instances of this. In each case the main entrance opens into a large entrance hall running right through the building, fitted with doors at each end, and having the waiting-rooms, etc., on either side. These rooms are entered by swinging doors, and are thus shut away from the general rush and bustle of the station. Ticket windows in the waiting-rooms and in the main hall, also prevent the unnecessary mixing of passengers who are waiting and those who are going direct to the train.

The Jersey City terminal station of the Pennsylvania R. R. (which was destroyed by fire some months ago) was one of the worst examples of the objectionable plan above referred to, the crowds of passengers from the New York ferry-boats having to pour through the waiting-room, on their way to the trains, and the same objectionable feature is retained in the new Pittsburg station of the same road (Eng. News, Dec. 1, 1898). In the new Jersey City station, however, the head-house will give place to a side-house, and a wide covered space or lobby will extend across the end of the trainshed, so that passengers from the ferry-boats are landed on one side of this corridor and can go direct to the platforms. Those who have to procure tickets or sleeping-car accommodation will still have to pass through the waiting-room, an arrangement which might easily have been avoided, but those who have been familiar with the inconvenience of the old station will not be inclined to make strenuous objection to this minor defect.

In stations where the tracks are above or below the street level, one of the first points to be considered is whether the main floor should be on the street or track level. Of two new stations at Omaha, both of which have the main entrance from a viaduct crossing the tracks, one has merely an entrance hall at the viaduct level, while the other has the waiting-rooms, ticket-offices, dining-rooms, etc., at this level, with a hall and baggage-room, etc., below. From an operating point of view it seems decidedly the better plan to have the ticket offices and waiting-rooms at the track level, so that the former may be as near the platforms as possible, while passengers can see or ascertain when their trains are ready without running up and down stairs. The Chicago terminal station of the Chicago & Northwestern Ry. has the main waiting-rooms at the street level, with ticket offices on the track floor below, in a large enclosed space which forms an auxiliary waiting-room. This arrangement is very convenient, as persons having any considerable time to wait have a comfortable and quiet room, free from the noise and bustle of the general business of the station.

In another article we shall take up some of the other matters relating to station design, including platforms and trainsheds.

LETTERS TO THE EDITOR.

Gang Foremen as Inspectors of Pipe Laying.

Sir: I enclose a clause clipped from a specification recently sent us, the provisions of which we have never before seen advocated by engineers. Why not appoint the contractor both engineer and inspector and be done with it?

Subscriber.

(The clipping enclosed is as follows.—Ed.)

The Engineer is hereby granted the right and is authorized to select and appoint such person or persons as he may deem proper to represent the City to inspect the work done under this agreement, and see that said work conforms in every respect to his plans, specifications and instructions; and the Contractor hereby agrees that said inspectors shall be afforded all proper facilities for discharging the duties assigned them, and that the City shall deduct and retain out of the money which may be due or become due to him under this agreement, the full cost of maintaining this system of inspection. By consent of the Engineer these Inspectors may also serve as foremen of the pipe-laying gang.

First Chief Engineer of the Camden & Atlantic R. R.

Sir: In your issue of Dec. 29, 1898, the statement is made, in an obituary notice of the late Daniel Morris, of Atlantic City, N. J., that he laid out and was constructing engineer of the first railroad to that place. This is an error. My father, Richard B. Osborne, who has acted as Chief Engineer during construction of the Philadelphia & Reading R. R., the Richmond wharves at Philadelphia, the Waterford & Limerick Ry. in Ireland, and other works, also held that position on the first railroad to Atlantic City—the Camden & Atlantic—during preliminary surveys, location, entire construction, and for years afterwards. In connection with it he laid out Atlantic City and named it and its streets, his plans for the same having met the hearty endorsement of his Board of Directors. Mr. Morris, who later became City Surveyor, held only the position of rodman on the party of the Assistant to Mr. Osborne, in staking out the city from the latter's plans. Will you kindly make a note of these facts, so that the error may be corrected, as it has been rather widely circulated by correspondents not familiar with the facts.

Respectfully,

Melmoth M. Osborne,

1003 Spruce St., Philadelphia, Pa., Jan. 7, 1899.

Hydraulic Cements Containing a Large Percentage of Sulphides.

Sir: Referring to a letter in your issue of Dec. 29, 1898, on the above subject by Mr. S. Bent Russell, the explanation of the behavior of the cement he refers to is clearly indicated by the data he supplies, and if, as appears to be the case, the cement was one made from waste iron slag the matter is plainer still, for then the action of an appreciable quantity of caustic lime is to be reckoned on as helping forward the disintegration materially.

But taking the figures as Mr. Russell gives them, we have, first, quite as much magnesia as is wanted for a cement of the Portland class, and, second, we have an excess of sulphur, more than enough to ruin any such cement.

In Europe, after 40 years' trial, these cements high in sulphides have found no favor. They often give fair results when used entirely under water, for there the sulphides are protected from oxygen, but they are untrustworthy if exposed to the free air. The only remedy is to reduce the objectionable factors to reasonable limits, which is not a difficult operation, but it must not be done on paper only.

A cement high in sulphides will often, if new and kept in water, pass the ordinary Portland test, but a chemical analysis will indicate accurately what may be expected of it at no very distant date.

Yours respectfully.

H. J. Livingston.

Baltimore, Md., Dec. 31, 1898.

Cubic Contents of Asphaltic Mixtures.

Sir: There is one point in your extract from Mr. J. H. Pearson's paper on "Cost of Asphalt Street Paving in Louisville, Ky.," in your issue of Dec. 15, on which I wish to ask further information. Mr. Pearson seems to figure on 27 cu. ft. of unmixed ingredients making 1 cu. yd. of asphaltic concrete for wearing surface after mixing.

It is well known that in hydraulic cement mortar and concrete the volume of ingredients before mixing, not including water, is considerably in excess of the volume of the resulting mortar or concrete. Is not this likewise true of asphaltic concrete?

In the paper referred to, the largest item mentioned among the ingredients making up the 27 cu. ft. is 21.87 cu. ft. of sand. This probably contains 30%, more or less, or say 7 cu. ft. of voids. Would not a large part of the remaining 5.13 cu. ft. of other ingredients go toward filling the 7 cu. ft. of voids, thus yielding only about 22, instead of 27, cu. ft. of concrete?

Very truly,

H. P. Boardman.

Chicago, Ill., Dec. 22, 1898.

(The above letter was submitted to Mr. Pearson, and his reply is given below.—Ed.)

Sir: To Mr. Boardman's query regarding "Cubic Contents of Asphaltic Mixtures," I would reply as follows: I do not understand how an engineer can find any similarity between Trinidad Lake asphalt and water. The former is certainly a solid in both its natural and refined state, and is not far from a solid in its heated state. Water is a liquid, unless frozen. If a grain of sand is wet with water the film of water surrounding it is exceedingly thin. But if this sand grain is dried again it would be nearly impossible to coat it with a film of Trinidad Lake asphalt, suitable for street paving purposes, without very materially increasing its bulk.

Asphalt paving mixtures, ready for street use, are not similar to concrete. The latter, if well made, is mixed before being laid, and all the voids are practically though not entirely filled. When a properly made asphalt mixture is hauled to the street, it resembles black sand, or more nearly sugar, it is a loose mass, and as each sand grain is made larger by its coating of asphalt, there are larger voids than in the same amount of clean sand. Therefore, the bulk of the asphalt must be taken into account; and so must the lime-dust, for it sticks to the coated sand grains and further increases their size. The voids are not filled until the mixture is rolled; and then it will be probably found that a cubic yard of the loose mixture will be less than 27 cu. ft. of the rolled solid paving. It should be noted that only a part of my report was published in Engineering News, otherwise what I had to say regarding cubic contents would, probably, have been better understood.

Personally, I believe it is a fact, though I cannot prove it, that contractors use less of Trinidad asphalt and petroleum residium, per cubic yard, than I stated, and more sand and limedust. This suggests a difference existing between rock asphalt and lake asphalt in paving mixtures. One cubic yard of a mixture of the various ingredients of Trinidad Lake asphalt paving will make less than a cubic yard when rolled. But asphaltic rock, in its natural state, is already as much consolidated as it is possible to consolidate sandstone or limestone; and when pulverized, it increases in bulk and one cubic yard of the natural rock, makes more than one cubic yard of paving mixture, and amounts very nearly to one cubic yard in place after two to five years' traffic has been on it and the mixture has nearly returned to its rock state.

Yours truly,

J. H. Pearson.

424 Belgravia, Louisville, Ky., Jan. 1, 1899.

A Proposed New Wire Gage.

Sir: Of the various wire gages, French, English and American, that I have observed, there is a want of simplicity in their construction. The gages have too many decimals and there is no simple method that I can find for calculating the gage from its number or the nearest number from a given thickness. This information must be obtained by consulting a table of gages. The following gage system and rule are offered as a simple means of giving this information: The inch and metric system are combined in such a manner as will make them practically interchangeable with the fewest possible digits in the gages.

The smallest gage is represented by No. 1 = 0.002 of an inch or 2 mils. = .05 millimeters, and ranging upward to No. 50 = 620 mils = 15.5 mm. This is on the assumption that 40 ins. = 1 meter. The true comparative value of No. 50 would be 620 x .0254 = 15.748 mm., a difference of about ¼-mm., equal to about the thickness of two sheets of legal cap paper.

My idea would be to make all gages by the metric system, and consider the inch system as equivalent to it, as shown in the following table:

Inch system in mils.			Metric system in millimeters.	
N	I	G	I	G
1	2	2	0.05	0.05
10	4	20	.1	.5
20	8	60	.2	1.5
30	16	140	.4	3.5
40	32	300	.8	7.5
50	64	620	1.6	15.5

Rule.—To make a gage table in mils and millimeters: Tabulate under the head of N for gage No.; I for increment and G for gage in mils and millimeters, respectively. Under N place the gage Nos. 1, 10, 20, etc. Under I and opposite No. 1 start with 2 mils or 0.05 mm., and increase in geometrical progression by multiplying successively by 2. Under G start with 2 and obtain the succeeding terms by subtracting the first term of the increment from any given term, multiplying the difference by 10. This will give the gages of all the tens. The numbers in the column of increment are to be added successively for ten numbers to give the gages of the intervening numbers.

What is the gage of No. 38? The gage of 30 = 140. The increment between 30 and 40 is 16, 140 + 8 x 16 = 268. Therefore the gage of No. 38 = 268 mils.

What is the nearest gage number corresponding to a thickness of 0.5-in.? 0.5-in. = 500 mils, No. 40 = 300 mils, $\frac{500 - 300}{32} = 6$. Therefore No. 46 is the nearest number.

For the metric system divide the first term of the inch system by 40, and we get the first term of the metric system. This table is made up in a similar manner to the first, and used in like manner. It has fewer digits in the gage column than the inch system.

By making diagrams of the different gages in use and comparing the proposed gage with them it will be found that from No. 1 to 30 the proposed gage will conform closely with the Birmingham gold and silver gage, and from 30 to 46 it will conform well with the New British Standard and the Roebling gages. So the proposed gage is adapted for all kinds of metal.

John Waterhouse.

195 Broadway, New York, Dec. 23, 1898.

(We refrain from comment upon our correspondent's proposal to add a new wire gage to the number already in existence. For the benefit of some of our readers who at various times have indicated a belief that Engineering News was in error in its spelling of the word "gage," we may remark that this journal uses the "Century Dictionary" as its standard for orthography.—Ed.)

Concerning Caisson Disease and its Prevention.

Sir: Since the pneumatic process has been in use for sub-aqueous workings, the injurious effect of high air pressures on the human system, known as caisson disease, has been made the subject of much study, with the result that means have been found for decreasing this danger to men working in compressed air.

Although it has always been recommended that considerable time should be taken in relieving the pressure when coming out of the compressed air, it remained for M. Hersent to show the great importance of coming out very slowly from high air pressures, by determining experimentally that a man may be subjected to pressures up to 76.8 lbs. per sq. in. without injury, if sufficient time is afterwards taken in relieving the pressure. Three hours and three minutes were allowed by M. Hersent in reducing the pressure from 76.8 lbs. to zero.

In these experiments the maximum pressure of each test was maintained for the uniform period of one hour. Had a series of tests also been made, to determine the effect of increasing the time for maintaining the full pressure, it might have been ascertained how far the pressure itself enters in causing caisson disease, aside from the effect resulting from the relieving of the pressure. As yet there is nothing to prove that a man may not remain an indefinite time in the compressed air, if corresponding precautions are taken in returning to natural conditions. In the rules for working in compressed air, which were presented to the late International Congress on Internal Navigation, it is stated that there is no necessity for limiting the time spent in the working chamber, provided the pressure is not excessive. In pressures that have come in the writer's own experience, while at the Hudson Tunnel, and while in charge of operations at the East River Gas Tunnel, there were several indications to show that the dangerous conditions are only met when coming out of the air pressure. A man was never overcome in any way while entering the air pressure through the air-lock, nor while at work in the compressed-air chamber. In the Hudson Tunnel some mules were kept continuously in an air pressure of 30 lbs. for nearly two years, working regularly without any apparent ill effects. When that work was shut down, those brought too quickly out of the pressure, died; the others, as more care was then taken in bringing them through the air-lock, suffered no ill effects from their long exposure to compressed air.

On works where the pneumatic process is employed, rarely if ever is more time taken by the men in coming out of the compressed air than three minutes per atmosphere of pressure; the danger is avoided when the pressure is increased, by decreasing the number of working hours. At an hydraulic head of 100 ft., two shifts of 40 minutes each, now constitute a day's work. The unwillingness of the men to take more time in coming out of the air pressure is largely due to the disagreeable conditions experienced in the air-lock. By the relieving of the pressure a thick freezing fog is formed, and with no means provided for heating and ventilating the air-lock, a man is glad enough to escape from its icy grasp as quickly as possible.

In all heavy compressed air work, with our present knowledge, it should be insisted on, first, that sufficient time be taken in coming out of the pressure, and, second, the lock should be made so comfortable that the men would have no reason to insist on being quickly released. To compel the first, the relieving of the pressure should be mechanically regulated. As to the second, with a small compressor installed on top, supplying hot dry air to the air-lock, by proper arrangement the cold foggy conditions due to expansion of air could be entirely removed.

The writer believes that caisson disease results from an excess of carbonic acid gas accumulated in the blood while in the air pressure, which is released from solution on coming out of the compressed air, and that the gas effects the disastrous results by interfering in a purely mechanical way with the natural action of the blood in the tissues.

In normal conditions the blood holds in solution some of the carbonic acid gas formed in the process of breathing; but under an increased air pressure the capacity of the blood to dissolve this gas is increased in direct proportion. When, therefore, a man enters the compressed air, the amount of carbonic acid gas held by the blood will gradually increase until the point of saturation corresponding to the pressure is reached. No evil effects result from this excess of carbonic acid gas in the blood as long as one remains in the compressed air, but on coming out from high pressures, unless a long time is taken in the air-lock, it is impossible for the blood to rid itself through the lungs of this excess of gas as quickly as the pressure is reduced, and consequently an effervescence takes place in the blood. The gas so released by obstructing the action of the blood may be responsible for the serious consequences known as caisson disease.

Walton I. Aims.

35 Broadway, New York, Dec. 28, 1898.

Notes and Queries.

In the discussion by Mr. Geo. Hill of Mr. Bryan's paper on "The Mechanical Plant of a Modern Commercial Building," on p. 7 of our issue of Jan. 5, it should have been stated that Mr. Hill was responsible for the design of the mechanical plant of each of the three buildings which he compared with the Commerce Realty building, the plant of which was designed by Bryan & Humphreys.

THE SANITATION AND PUBLIC WORKS OF HAVANA.

To everyone familiar with the conditions existing in Cuba, it is apparent that one of the greatest, if not the greatest task now before the Government, is the radical reform of the sanitary condition of Havana. That city is and will remain the commercial, financial and governmental center of all Cuba. All the work for the renovation of the island must be carried on from that city as headquarters; but until the sanitary conditions there are changed, all Americans who go there, either to carry on the work of reform as governtal officers, or to bring capital and energy to the aid of the island's industry and commerce, must run great risk of disease and death.

The difficult problem which present conditions present to American sanitary engineers has been well set forth recently by two independent authorities. One of these is Gen. Francis V. Greene, M. Am. Soc. C. E., late in command of the Second Division, Seventh Army Corps of the U. S. troops in Cuba. Gen. Greene's statement was published in the New York "Times" for Jan. 1, 1899. The other authority is none other than the late Col. Waring, whose work in Cuba is summarized in the January "Forum," in an article entitled "Colonel Waring on the Sanitation of Havana," by Mr. G. E. Hill, who has been for some years Col. Waring's private secretary.

General Greene's Review.

General Greene was in Havana from early in November until Dec. 22, when he was succeeded in the administration of the city by General Wm. L. Ludlow, M. Am. Soc. C. E. General Greene left with his successor some memoranda, including his observations of the sanitary, financial and other phases of the city, from which we have abstracted the following:

The thickly populated section of Havana is a tract about 2,200 yds. square, and has about 70 miles of streets, of which not more than 40% are paved. Most of the pavement is of trap blocks, and all is "worn out and in bad order." The unpaved streets are macadamized with soft coral rock, and are full of deep holes. Most of the streets are very narrow, even in the newer part of the city.

There are a few storm sewers, and also a few lines of private sewers. The sanitary curse of the city are the privy vaults and cesspools, which are more fully described on Col. Waring's report below. The porous limestone or coral rock underlying the city allows the contents of these cesspools to slowly seep through it to the bay.

Prior to October, 1897, the streets were cleaned under a five-year contract for $86,213, and the material gathered was removed under another contract for $36,000 a year. Since the date named the work has been carried on under temporary contracts. The material, until the late blockade, was shipped by rail to a point about eight miles south of the city and there dumped and left in piles, the stench from which was almost intolerable. During the blockade the street sweepings were deposited in a marsh near the Christina St. railway station, creating a great nuisance, which must be abated. General Greene describes the street cleaning work inaugurated by him as follows:

The habits of the inhabitants of Havana, including the rich as well as the poor, are very different from American standards in the matter of sanitation. For several months past the reconcentrados and other people of the town, as well as the soldiers who have swarmed in the streets, have been in the habit of using the public streets as open privies, and the unpaved streets were covered with enormous quantities of foul human excrement. On receiving authority from the Secretary of War to begin cleaning the city, I decided not to interfere in any way with the street cleaning contractor, whose work on the paved streets is fairly well done, but to devote all the means at my disposal to cleaning up this excrement and generally cleaning the unpaved streets. This work has been in progress since Dec. 3, with very satisfactory results. The work is not done by contract, but by days' labor, the laborers being hired and paid directly by United States officers. The filth is scraped from the unpaved streets, removed in carts to barges, and thence carried out to sea and dumped in the Gulf. As fast as each street is cleaned it is thoroughly sprinkled with lime, and notices are posted on the fences and houses warning the inhabitants that this street has been cleaned at the expense of the United States, and the depositing of excrement, filth, or rubbish on the same will be severely punished, in accordance with the existing city ordinances. These notices are signed by the Alcalde of the city, who has also stationed police in these streets to prevent the defiling of them.

The temporary contract with the street cleaning contractor is paid for from week to week, and it expires on Dec. 31. He is quite willing to continue the work, and probably at the same rate ($2,850 per week), and it will probably be best to make a temporary arrangement with him on this basis until permanent plans for street cleaning can be made. I think these had better be on the same lines as those instituted by Col. Waring in New York; that is, the cleaning of the streets by hand during the day time and the removal of the refuse to sea in self-dumping barges. This will cost more than the present system, but it will be very much more effective.

The one slaughter-house is owned by the city and poorly operated. All the wastes are dumped into a shallow creek, so near the center of population as to be highly objectionable, to say the least.

There is no lack of health regulations, but they are not enforced. Dairies are maintained in houses used to shelter human beings, and other rules of sanitation and decency are violated in the most shocking manner.

The harbor is exceedingly foul. While there are but few sewers discharging into it, yet it receives the seepage from polluted soil and all the surface washings of the city. Notwithstanding the foulness of the harbor, General Greene does not think it is one of the principal sources of infection, and believes that other sanitary improvements should precede any attempt to purify the harbor. Very few cases of yellow fever are reported on ships lying in the harbor.

A plan for sewerage, paving and garbage disposal for Havana was developed by an American contractor in 1894-5, and has been formally approved by the city council, so far as its technical features are concerned, but no means have been devised to raise the $7,000,000 or more which the work would cost. A partial separate system of sewerage was proposed with chemical treatment before final disposal. Apparently the plan included a cremation furnace for burning garbage and the sludge from the sewage purification works.

The water supply of the city is excellent. There are said to be 18,000 houses in the city, of which 9,233 were reported by the city council in 1897 as being connected with the public supply.

A comprehensive system of electric street railways is needed, the horse-car, omnibus and dummy lines now in use covering only a part of the city, besides being obsolete as a means of communication. On Dec. 7, 1898, the then existing government attempted to grant privileges of extensions to the street railway company, but on Dec. 14, on account of protests from the U. S. Evacuation Commission, the Governor-General directed that all proceedings in the matter be suspended until further notice, without prejudice to either side.

The financial condition of Havana has an important bearing upon raising money for public improvements. The total indebtedness, bonded and floating, is now about $12,500,000, which General Greene says is not excessive for a city the size of Havana. The total estimated revenue for the last fiscal year is about $2,000,000, or some $10 to $8 per capita, for an estimated population of 200,000 to 250,000.

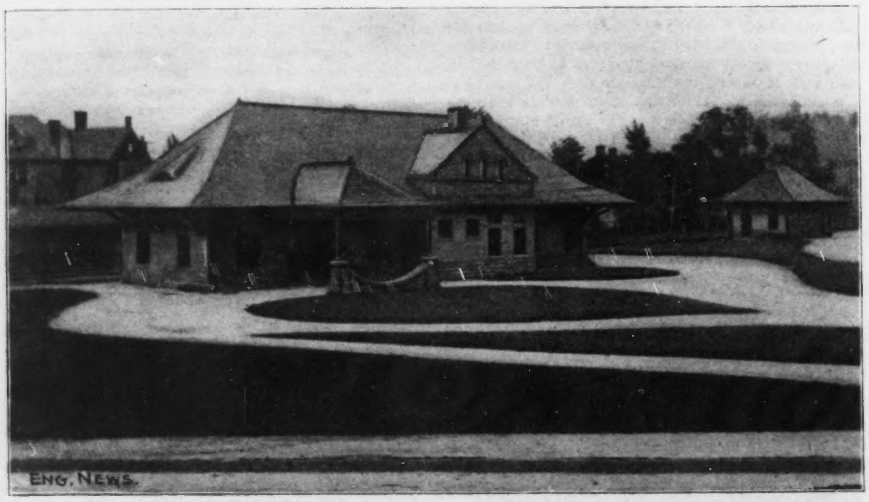


FIG. 1.—NEW PITTSBURG & LAKE ERIE R. R. PASSENGER STATION AT BEAVER, PA.

General Greene's recapitulation of his sanitary review of the city is as follows:

From the foregoing it is apparent that the first steps toward sanitation are the improvement of the slaughter house, the cleaning of cesspools, the inauguration of a proper system of street cleaning, and devising and rigid enforcement of health regulations. I have therefore advised that immediately on taking possession of the city government a board be appointed, consisting of three army surgeons and two civilians—one from New York and one from Chicago—of long experience on the health boards in those cities; that this board study the sanitary conditions of the city and draw up a new code of sanitary regulations, including the management of the hospitals, and that this code be rigidly enforced by the new city police, assisted by such number of sanitary inspectors as may prove to be necessary. In this manner I believe that the sanitary conditions can be improved and the death rate enormously reduced before the next rainy season sets in. The death rate in October last was at the rate of 133 per 1,000 per annum; in December it has been reduced to 106, and with only two deaths per week from yellow fever.

In order to completely stamp out yellow fever it will be necessary to destroy a limited number of the worst infected houses occupied by the poorest classes, to construct a system of sewers, and lay new pavements. This will involve a very large expenditure of money, and it is not at present clear how the city can raise this money. It is probable, however, that a feasible financial scheme could be devised after thorough study, and in the meantime a commission of engineers should be appointed to study the problem, and either acquire the existing surveys by purchase at a fair valuation or else make new surveys, and a definite report covering the whole ground, so that the matter may be intelligently considered.

Mr. Hill's Presentation of Colonel Waring's Notes and Recommendations.

The tragic end of Colonel Waring's life adds to the interest of his memoranda on the sanitation of Havana. He sailed from New York for Havana on Oct. 8, in behalf of the U. S. Government; remained there from Oct. 13 to 21, collecting data, reached New York on Oct. 25, ill with what was at first diagnosed as malarial fever, and died of yellow fever four days later.

Mr. Hill's article was prepared principally from Colonel Waring's notes, supplemented, perhaps, by information obtained from intimate association with him, and doubtless by data which Mr. Hill had himself gathered as assistant to Colonel Waring. The first part of the article reviews the history of yellow fever in Cuba, North America and Spain, states that Cuba, and especially Havana, has been and continues to be the origin of the larger part of the disease, and that its occurrence in the United States, both in frequency and number of cases at each visitation, have been diminishing for a century, owing principally to improved municipal sanitation.

The present unsanitary condition of Havana is set forth graphically, as an explanation of the prevalence of yellow fever in the city and an excessive mortality from other diseases. About 90% of the population live in houses one-story high, without cellars or ventilation beneath, and covering the whole lot, except for the small central courts. The front rooms of the houses are used as parlors and living-rooms; beyond is a court upon which open the dining-room and sleeping-rooms. Still further back is another court, on which are the "kitchen, stable and privy, practically all in one." The privies are rarely ventilated. Cesspools receive the wastes of the kitchens and privy.

At the rare intervals when privy vaults and cesspools are cleaned, their contents are carried through the dining-rooms and parlors in dripping ladles to carts in the streets. The carts are often dumped in some narrow street or alley, instead of at the prescribed place of deposit.

The account of the public works and general sanitation of the city does not differ materially in the two reviews, but Colonel Waring, naturally enough, laid more stress than does General Greene upon the foulness of the paved streets. Colonel Waring also described some low, marsh lands which he believed to be largely responsible for the malaria that infests the city.

The improvements recommended by Colonel Waring as absolutely necessary for the sanitary redemption of Havana, are as follows:

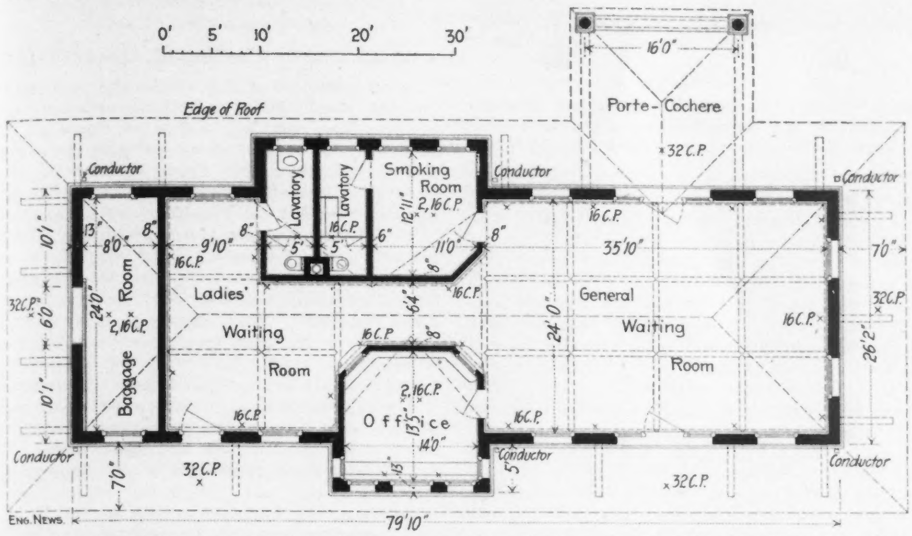


FIG. 2.—FLOOR PLAN OF PITTSBURG & LAKE ERIE R. R. PASSENGER STATION AT BEAVER, PA.

(1) The organization of an efficient street cleaning department, "under the full control of a single commissioner, experienced in the conduct of such work." All wastes, except sewage, should be disposed of by this department, "by cremation and otherwise."

(2) The construction of a sanitary sewerage system, the sewage to be discharged into the harbor after being clarified "so that it would carry only its dissolved impurities." Dilution would be sufficient for the further care of the sewage, being about 6,000 to 1.

(3) The emptying of all privies and cesspools, after which they should be filled with clean earth. Each house should be connected with the sewers. Simple forms of automatic water-closets should be installed in every house, so designed that no foreign substance liable to obstruct the house connections or sewer could pass out of sight. These closets should be put in at public expense, as it is imperative that cesspools and privy vaults be abolished. Householders wishing more expensive plumbing than that offered without cost might be allowed to install it under proper supervision, at their own expense.

(4) All the streets should be paved with asphalt, thus rendering them "impervious alike to the rise of exhalations from the earth and the soakage of liquids into the earth."

(5) The erection of a new abattoir, with all modern appliances for utilizing the whole animal, so that there will be no refuse left for disposal.

(6) The construction of furnaces for burning garbage, dead animals, and all other matter except sewage that might serve as sources of infection.

(7) The reclamation and drainage of all, or at least a part, of the marshes, by diking and pumping.

(8) The installation of a power plant for the pumping just named, for pumping sewage where necessary, and for operating the abattoir.

These were all the specific recommendations found in Colonel Waring's notes. In explanation of there being no reference to cleaning the harbor by dredging, Mr. Hill states that if the wastes now emptied into it were excluded, nature could be relied on to care for the deposits already there.

To dredge the harbor now would stir up much dangerous matter, which after a few years of natural oxidation will become innocuous and can be removed as so much mud, if the deepening of the harbor is desired.

The cost of all the above described sanitary redeeming improvements is roughly estimated at $10,000,000. The most urgent work should be done before June 1, 1899, according to some of the last words written by Colonel Waring.

Since Mr. Hill's article appeared in the "Forum" an abstract of Colonel Waring's memoranda and recommendations, as prepared after his death and transmitted to the Government, has been sent out to the newspapers from Washington, under date of Jan. 8.

PITTSBURG & LAKE ERIE R. R. PASSENGER STATION AT BEAVER, PA.

By Karl J. C. Zinck.*

A good example of the attention which is being given by railway companies to secure attractiveness in the buildings and grounds of their smaller local passenger stations is furnished by the new station recently completed by the Pittsburg & Lake Erie R. R., at Beaver, Pa. This station is illustrated by the accompanying drawings and half-tone view; Fig. 1 being a general view of both the passenger station and adjacent freight house from the town side; Fig. 2, a plan of the passenger station, and Fig. 3, the general layout of the grounds, walks, drainage system, etc.

The station building proper has foundation walls, piers, coping of area walls, and cellar steps of Beaver Valley sandstone. The superstructure is of vitrified buff brick. Rock-faced Killbuck brown stone is employed in the window sills, arch stones, cap-stone courses and in the wall and corbels supporting the porte-cochere. The ashlar, built to the height of the window sills, is also of this same brown stone, and gives a fine effect of solidity and durability. All the mortar employed in construction was made of Black Diamond cement. Peach bottom slate is used on the roof, and the gutters and conductors are of 20-oz. and 16-oz. copper, respectively.

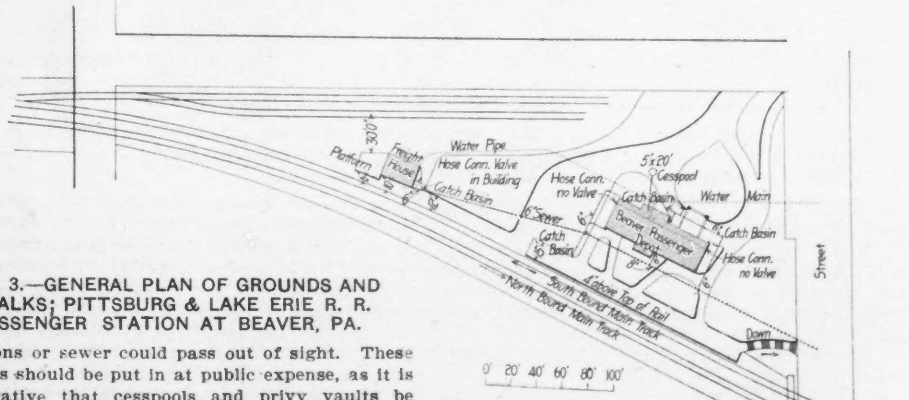


FIG. 3.—GENERAL PLAN OF GROUNDS AND WALKS; PITTSBURG & LAKE ERIE R. R. PASSENGER STATION AT BEAVER, PA.

The interior is commodious. The ladies' waiting room, gentlemen's waiting room, and connecting passageway have a 5-ft. wainscoting of panelled oak, with a 10-in. molded oak base-board; the wall above being faced with buff brick. The windows, of best American plate glass, are framed in oak, natural finish, and pivot-swung. The heavy doors and door frames are also oak. Transoms of opalescent art glass swing above the doors, and wrought-iron brackets set in the wall spaces sup-

*Assistant Engineer, Pittsburg & Lake Erie R. R., Pittsburg, Pa.

port the electric lights. The ceilings of the waiting rooms are panelled in oak. Yellow pine is used to finish the smoking room, lavatories, and office, also in the overhanging roof, and the posts and beams supporting the porte-cochere. The flooring of all except the baggage room is of selected and matched maple; the baggage room having a floor of oak. The interior walls of the baggage room are hard red brick, sheathed 6 ft. high with oak. Heat is supplied by a furnace in the cellar and pedestal registers are placed in the different rooms.

The freight depot stands near by, and is built of vitrified buff brick with brown stone trimmings to correspond to the passenger station. It is 28.8 ft. × 18.2 ft., with most convenient interior arrangement.

The paths about the station, and the driveway which passes under the porte-cochere, are of gravel packed down hard and covered with limestone screenings. The approach from the town side has a heart-shaped grass plot framed by a broad driveway. The cost of the structures was about $8,000 for the passenger station, and $2,000 for the freight station. The contractors were Breitwieser & Co., of Pittsburg, Pa.

THE LIQUID THEORY FOR ASPHALT MIXTURES.

In an article published in the "American Gas Light Journal," Mr. A. W. Dow, of Washington, D. C., suggests that in studying the causes of certain failures in asphalt pavements sufficient attention has not been paid by engineers to controlling physical laws; and he points out how poor pavement can be made with good asphalt by using sand not suitable for this purpose. Mr. Dow contends that while the cementing materials in general use in engineering work are actually solids, and are ruled by the laws governing the cohesion and adhesion of solids for each other, asphalt paving cements are in every sense liquids, and they involve the laws governing the attraction and adhesion of liquids for solids.

Asphalt cements flow at all temperatures, the flow being quite marked at 75° F.; and as the temperature is raised or lowered the flow becomes more rapid or sluggish, in a degree varying with different asphalt cements. He notes that such cement oozes through the smallest cracks in barrels or boxes; and he has experimented with this flow at 25°, 75° and 140° F. On hot days, asphalt pavements reach the latter temperature.

Mr. Dow says that these thick liquids belong to the class of fluids that will rise in a capillary tube, thus showing their strong attraction for solid bodies; and he believes that the law of capillarity is the chief law involved in cementing asphalt mixtures, and when applied it will explain hitherto puzzling or unexplainable phenomena. But while asphalt cements may be regarded as liquids, they also have another property not commonly belonging to liquids; they become brittle at certain temperatures. This brittleness increases as the temperature lowers; but we may increase or decrease the softness of an asphalt cement by the use of a flux or harder asphalt; consequently, it is desirable to have the cement as soft as possible; so that the temperaure at which it becomes brittle is at the minimum degree.

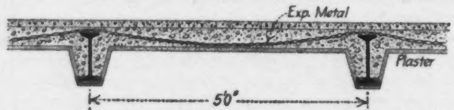


Fig. 1.—Section of Expanded Metal and Concrete Floor, for the New Refinery of the New York Sugar Refining Co., Long Island City, N. Y.

The selection of the sand used with the asphalt cement is all important. From what has been said, it is evident that in asphalt mixtures the sand grains of various sizes are held together by the forces of attraction and adhesion of a liquid, that we call asphalt cement. Just as the sand grains on a beach, which the tide has just left, are held so firmly together by the water that a wagon may be driven over this beach and scarcely leave a mark. That this hardness of the beach is due to the presence of water in the voids of the sand is proven by the fact that when the surface dries the sand is loose and easily displaced.

Practical tests with water will show that fine sand packs remarkably hard, while the coarser sand packs more loosely. In practice the same is true in asphalt mixtures; using the same asphalt cement, a finer sand produces a harder mixture than a coarse sand, and a much softer asphalt cement, with fine sand, makes an equally hard mixture. This is because the voids in the finer sand are smaller and the sand grains are consequently closer together. It is a well-known fact that the smaller the space between two solid bodies held together by the attraction of a liquid between them, the greater is the adhesion. The most desirable sand, however, is one so graded from coarse to fine that all the large voids are filled with smaller grains of sand, and the smaller voids with still finer grains. Such a sand is more easily handled in the manufacture of the pavement and requires less asphalt cement, as the percentage of voids is less and the total surface area of the sand grains is smaller.

But the shape of the sand grains has also a considerable influence on the hardness of the mixture. The rounder and smoother the grains of sand the softer will be the pavement, other conditions being equal. This was proven by microscopic and mesh examinations of the sand used in different pavements in Washington, which showed 20° difference in penetration, or hardness. It was found, here and in other cases, that, all else being the same, the mixture made with angular sand was the harder; and this is due to the keying into each other of the irregular sand grains. Too sharp a sand, or one so jagged as to be liable to have pieces easily broken off, is not desirable, as it tends to assume the round form. As the sand forms from 80 to 90% of the pavement, Mr. Dow suggests that it is the more important ingredient; and when a pavement is at fault the sand is probably more responsible for the failure than the asphalt, which now bears the brunt of all failures.

A SEVERE TEST OF A MONOLITHIC CONCRETE FLOORS.

As an indication of the tribulations to which the owners of buildings sometimes subject fireproofing, and particularly fireproof floors, we present herewith several views taken in the new refinery of the New York Sugar Refining Co. This building is located on the East River water front in Long Island City. The expanded metal system of fireproofing was employed throughout, and altogether there were some 200,000 sq. ft. of this style of flooring laid on 12-in. steel I-beams spaced from 3½ ft. to 5 ft. apart. Fig. 1 is a typical section of the floor. The concrete plate varies from 3½ ins. to 4 ins. thick, and has a single thickness of expanded metal. The surfacing is 1½ ins. of granolithic concrete. The concrete was composed of 1 part Atlas cement, 2 parts sand, and 5 parts cinders. Fig. 2 shows the appearance of the completed floor, both on top and from below. The beam and column protection is also quite clearly shown.

Taking a floor like this, which, as well be seen, is practically a monolith, the owners have pierced it for pipes, tanks, etc., until in some cases only a very few of the original arches remain intact as built. Referring, for example, to Fig. 3, it will be noticed that the bulk of the floor has been cut away to allow the great refining tanks to project up through it. Fig. 4 is another case where a large gash has been cut to allow for the swing of a lever. Here it will be seen the overhanging shelf has been strengthened by two brackets. In most instances, however, nothing has been done to strengthen the parts which have been left standing, and they are now carrying without trouble the loads which come upon them. As an example of one of the advantages of a monolithic floor construction, the views given here are instructive. It is safe to say that no system of construction, consisting of bonded materials, like blocks and tiles laid in mortar, could have been subjected to any such cutting up as the accompanying cuts show this monolithic concrete flooring to have undergone. The views selected are, moreover, typical of what may be seen in places all through the building, where pipes and tanks extend from floor to floor. For the matter from which our illustrations have been prepared we are indebted to the New York Expanded Metal Co., of New York city.

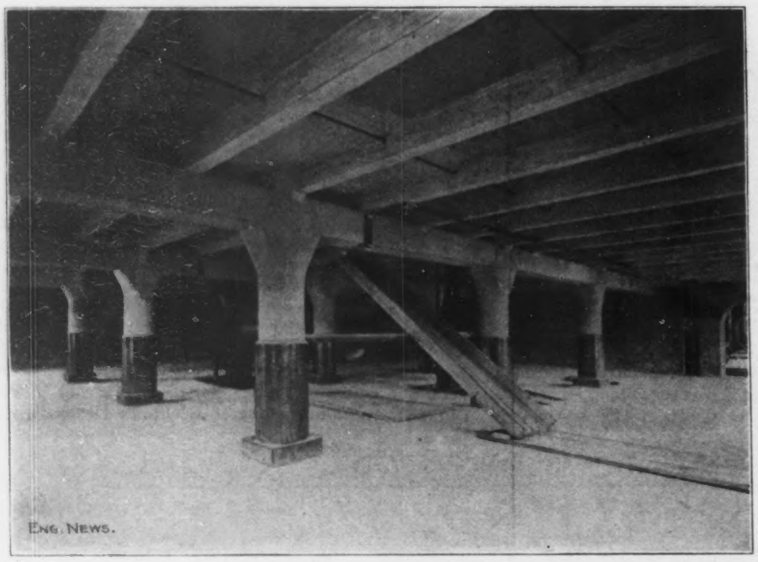


FIG. 2.—INTERIOR VIEW OF THE NEW YORK SUGAR REFINING CO.'S NEW REFINERY, SHOWING FIREPROOF FLOORS AND COLUMN AND BEAM FIREPROOFING.

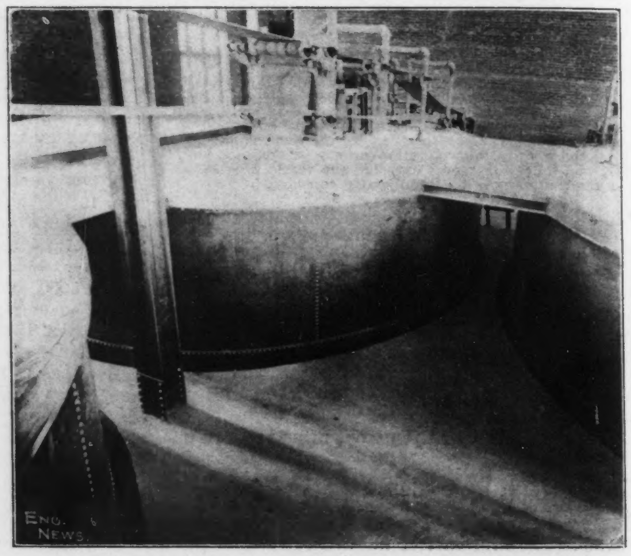


FIG. 3.—INTERIOR VIEW OF THE NEW YORK SUGAR REFINING CO.'S NEW REFINERY, SHOWING MANNER IN WHICH CONCRETE FLOORS WERE CUT FOR LARGE TANKS.

HYGIENIC PRECAUTIONS TO BE OBSERVED IN CONDUCTING PUBLIC WORK IN PARIS.

It has long been known that in many cases excavation in the soil of cities, the demolition of old buildings, etc., have given rise to outbreaks of epidemic diseases, and it has been recognized that some precautions were absolutely necessary. In 1887 the Sanitary Council of the Seine issued a set of regulations to be observed by those engaged in work of this character. But these regulations, when applied in practice, were found to be too general, and on Nov. 20, 1898, a new set of more precise instructions was issued by the Prefect of Police, bearing not only upon the regular engineering work performed each year in Paris, but especially upon the great works now in progress on the banks of the Seine for the Exposition of 1900. The basis of these regulations is a report made to the Prefecture de la Seine by its architect, M. Bunel, acting for the Sanitary Commission. This report is given in abstract in "Le Genie Civil," as follows:

The Commission divided the execution of public works into three distinct operations: (1) The tearing down of appropriated property. (2) The levelling of the ground, and works of road-making and draining. (3) Excavation for the erection of new structures. In performing the first class of work, contractors were required to observe the following regulations:

(1) The cleaning up, sprinkling and sweeping of all property to be demolished, and the burning upon the spot of all the resulting refuse. (2) The disinfection, by the municipal service, of all suspected property, or any property contaminated within five years by any contagious disease. (3)

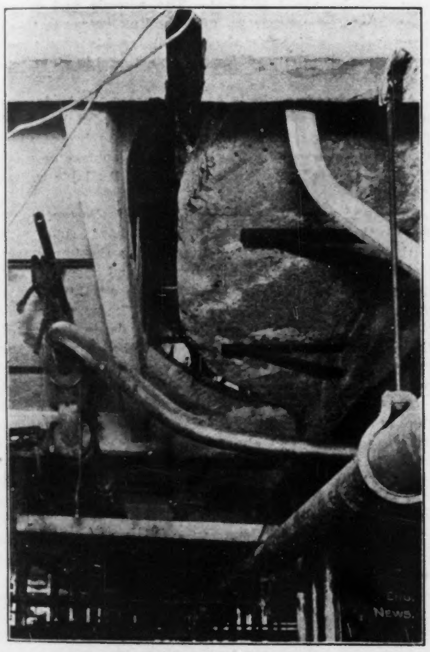


Fig. 4.—Interior View of the New York Sugar Refining Co.'s New Refinery, Showing a Cut in the Concrete Floor.

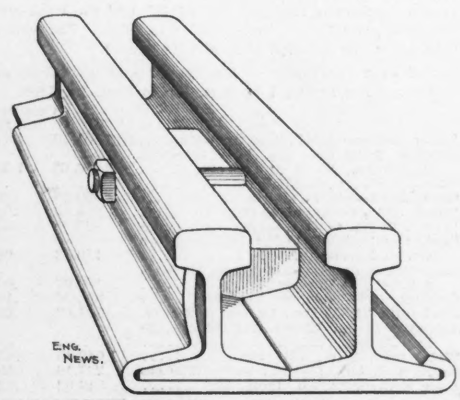
The emptying, cleaning and drying out of all pits, wells, cellars, house sewers, etc., and the washing of the walls or sides with a 5% solution of sulphate of iron, following with a coating of quicklime applied in a milky state. M. Bunel insists on the use of the quicklime, as it has an undoubted microbicide action, and is better than the "white lime of Meudon," which is often preferred. (4) When foundations are to be demolished, and in all subterranean excavation, any material, refuse or infected soil, recognized as capable of spreading endemic, epidemic or contagious diseases, must be treated to a solution of pulverized sulphate of iron and quicklime; and this earth and debris must be transported to one of the public "dumps" outside of Paris; and when deemed necessary, it shall be carried in covered wagons. (5) The erection of fences, with closely-fitting planks, isolating the houses to be demolished from those left standing. (6) The contractor must strictly conform to all the regulations imposed by the ordinance of July 26, 1862, fixing the method of work. The medical staff of the city is required to supervise the application of the first four of these hygienic measures; the other two come within the province of the building staff.

As a preliminary to these regulations, M. Bunel points out the influence exercised by the movement of soil upon the development of endemic and epidemic diseases; particularly, typhoid and intermittent fevers. In support of his contention he cites a great number of cases where the appearance of some scourge of this type coincided with the execution of great public works. He also insisted that as those engaged in the work of demolition would be the first exposed to the germs of disease, it was the duty of the inspectors of work to apply these measures wherever there was the least suspicion of infection.

The disinfecting solution, to be applied at every interruption in the work, was made up of 100 grammes of sulphate of iron to 200 grammes of quicklime for each square meter of surface treated, or ⅓-oz. avoirdupois of iron and ⅔-oz. of lime per sq. ft. This solution was employed with excellent results in clearing out the Versailles canal and the Lakes of Saint-Mande and d'Enghien.

A NEW GUARD-RAIL CLAMP.

The guard rails used at frogs and switches are generally secured only by spikes, and are thus entirely independent of the track rails. A much safer method, however, is to secure the guard rail to the track rail, as well as to the ties. Thus the proper width of throat or flangeway is maintained, and the guard rail cannot be forced from its proper position.



A New Guard-Rail Clamp; W. E. Dorwin, Inventor.

This may be effected by the use of bolts or clamps, or a combination of such fastenings, and the accompanying cut represents a new form of bolted clamp for guard rails. The clamp forms a base support for both rails. Its outer edge is turned up to grip the flange of the track rails, while the inner side fits the base and web of the guard rail like an angle bar, forming a good support against pressure from the wheel flanges. A spacing block between the rails gives the proper width of flangeway, and a bolt holds the rails, clamp and block together. The bolt passes through a semicircular groove in the block, which is thus prevented from shifting.

This device is known as the "Little Giant" guard-rail clamp, and is the invention of Mr. W. E. Dorwin, Manager of the Common-Sense Rail Joint Co., 304 Tacoma Building, Chicago, Ill.

A CIRCULATING DEVICE FOR BOILERS of the internally-fired type, which is now being tried in Chicago, consists of inclined tubes placed inside the furnace flue (close against the sides). At the lower end these connect with two curved headers above the sides of the deadplate, while at the upper ends the pipes are bent up vertically and pass through the crown of the combustion chamber. The headers take water from the bottom of the boiler, and the pipes discharge the heated water into the upper part of the boiler. The advantage claimed are an increased efficiency of the boiler, better circulation (and less scaling), a reduction in the time required for raising steam, and an economy in fuel consumption. After a six-months' trial of this device on four Scotch marine boilers (with Morison corrugated furnaces, at the Masonic Temple, Chicago, Ill., the results were so satisfactory that the manager, Mr. E. Williams, ordered the other four boilers similarly equipped. The circulating device is controlled and manufactured by Watson, Noble & Co., 277 Dearborn St., Chicago, Ill.

THE RUSSIAN ICE-BREAKING STEAMER "ERmack," built by Sir W. G. Armstrong, Whitworth & Co., at Newcastle-on-Tyne, for service in the Baltic, is thus described by the Newcastle "Daily Chronicle:" The boat is 305 ft. long, 71 ft. beam, and is 42½ ft. deep; when fully loaded the draft will be 25 ft. with a displacement of 8,000 tons. There are four sets of propelling engines—three are aft, driving three propellers, and one drives a forward propeller. The combined engine power is 10,000-HP. The bow is cut away and has an exceedingly long overhang, the purpose being to ride up on the ice and break it down, while the forward propeller disturbs the water under the ice and deprives it of this support. The stern of the ice-breaker contains a recess into which the "stem" of another vessel can be securely lashed and thus obtain the utmost protection. The convoying of merchant vessels is the primary object of this breaker, and she is expected to keep open the principal trade routes to Baltic ports in winter. The hull of the ice-breaker is divided into 48 water-tight compartments. No figures are given for the material and strength of the hull, and the cost is not mentioned.

GERMANY'S TRADE is being extended by a recent subsidy agreement made for the establishment of new steamship lines to ply between German ports and Japan, China, Australasia, and certain ports of Oceanica. The government agrees to pay for 15 years a subsidy of about $1,000,000 per year. Under the contract with the North-German Lloyds this company must build four steamers of not less than 6,000 tons each, and have them in service by Oct. 1, 1899, and Sept. 1 and Nov. 1 1900. Payments are to be made monthly by the government.

GERMANY'S NEW CANAL SYSTEM, under construction in part, includes two main canals—one joining the Rhine with the Dortmund-Ems Canal, and one joining the same canal with the Elbe. Side canals are to be run to Osnabruck, Hildesheim, Peine, Brunswick, Magdeburg, and possibly to Nienburg. The total cost of the system is estimated at $38,556,000. A toll of one-half pfennig, or 0.119-ct. per ton, is to be paid on goods that now go by rail or exceptional rates; other goods will pay from three-fourths to one pfennig per ton, or 0.178 to 0.238 ct.; these rates are per kilometer.

A SHIP-CANAL BETWEEN BERLIN AND STETTIN, to cost $100,000,000, will be advocated at the coming session of the Prussian Diet, says the London "Daily Mail." This project has been under discussion for some years, but was put aside for the time in favor of the North Sea and Baltic canals.

WORK ON THE HENNEPIN CANAL has progressed rapidly during 1898. At the beginning of the season there had been completed from the west end about 11 miles of channel, and from the east end about 8 miles were nearly completed, and the bulk of the work had been done on the next seven miles. During the year work was continued west from mile 15 and the channel was practically completed to mile 19. From mile 19 to 23 a large amount of work was done, but considerable additional work remains before the channel will be completed. The greatest progress has been made in the lock work however. During the season, from May to November, inclusive, the masonry for 14 locks, Nos. 8 to 21, inclusive, has been completed. These locks have lifts ranging from 8 ft. to 12 ft., and are built entirely of concrete. Altogether there are 38 locks on the canal, of which nine are not yet built. Besides the lock work, there have been built the foundations for two aqueducts, and about 20,000 tons of rubble stone for bank revetment have been delivered, and about half of it laid. A good start has been made on the highway bridge work by the Toledo Bridge Co., which has the contract. Five of these bridges have been built during the season, all crossing the portion of the channel which has been completed. The outlook is favorable for the continued active prosecution of the work during the coming season, and it is probable that several contracts for excavation will be let this winter. A full description of the Hennepin Canal, including the concrete lock work, was published in Engineering News of Feb. 14, 1898.

THE DEEP WATERWAYS COMMISSION, on Jan. 4, submitted its engineering report to Congress through Secretary of War Alger. The work reported upon is confined to the control of the level of Lake Erie, the projected Niagara ship-canal, the Oswego-Oneida-Mohawk route, and the St. Lawrence-Champlain route for a canal. The discharge from Lake Erie has been measured and the hydraulic slopes in the Niagara River determined. Two routes were surveyed for the Niagara River ship-canal; one leaving the river at Tonawanda, N. Y., passing west of Lockport, and reaching Lake Ontario at Olcott. The other leaves the Niagara River at La Salle, 5 miles below Tonawanda, and enters the Niagara River again near Lewiston. The Oswego-Oneida-Mohawk route for a ship canal, ending at West Troy, has been surveyed, and so has the St. Lawrence-Champlain route, excepting a few miles near Massena, N. Y. On all these lines certain rock borings have yet to be completed; but two or three months work will finish all the investigations in the field.

A LARGE DIPPER DREDGE is being built at the yards of Hingston & Woods, at Buffalo, N. Y. The hull of this machine is 136 ft. long, 42½ ft. beam and 13¼ ft. draft, and she is 32 ft. high from keel to top. This hull is strengthened by steel trusses running lengthwise of it and by wrought iron knees. The timber is all oak or Douglass fir. The spuds are 4 ft. square forward and 2 ft. square aft. The A-frame forward is 73 ft. high. The machinery, which was built by the Bucyrus Co., of South Milwaukee, Wis., consists of two 18 x 24-in. main engines, two 12 x 16-in. swinging engines, and two 10 x 16-in. dipper engines. The capacity of the dipper is 8¼ cu. yds.

A DEVICE FOR DEPOSITING DREDGED MATERIAL on shore, after taking it up from scows, is illustrated and described in the "Zeitschrift des Vereines Deutcher Ingenieure," for Dec. 24, 1898. The plan was submitted to the International Marine Congress, of Brussels, by A. Rudolph. There are two separate parallel hulls supporting a metallic tower by a system of beams spanning the space between the two boats. Immediately over this space, into which the scow is run, is a ladder dredge, with its chain of buckets. The material in the scow beneath is elevated by these buckets and emptied into a hopper in the tower; and the bottom of this hopper communicates with a long pipe suspended by stays reaching to the head of a steel shears resting on the outer edge of one boat and stayed back to the outer edge of the other boat. The purpose of this device is to deposit on shore the material dredged elsewhere and brought to it in ordinary scows. It was built by A. F. Smulders, of Rotterdam.

THE DIVERSION OF THE YUBA RIVER, in California, is being considered by the California Debris Commission. The scheme would call for the expenditure of above $1,000,000; the condemnation of an enormous area of land; the building of canals and levees and a dam at the point of diversion. The Yuba River is about one mile wide, and the plan proposed is to turn this river into a canal. Surveys are now in progress, and the report of the Commission for June, 1899, may present the full details of the proposed diversion—unless the plan be found impracticable in the interval.

THE CALIFORNIA PUBLIC WORKS COMMISSION, through Commissioner Ed. E. Leake, reports as follows on the work done between March 7, 1897, and Nov. 17, 1898, the reports of Chief Engineer M. A. Nunse and Asst. Engineer G. N. Randle being made parts of this report: The Elkhorn concrete weir, 2,000 ft. long and 15 ft. wide, has been completed; the five jetties, aggregating 6,000 ft. in length, and intended for the removal of the Newtown Shoals, have been finished at a cost of $80,000. The effect of these two improvements will be to deepen and correct the channel of the Sacramento River and to increase its carrying capacity in time of flood. The War Department has authorized five cut-offs on the San Joaquin River, and one of these is made and two others will be finished by February; the total estimated cost is $130,000. Commissioner Leake recommends extensions of the jurisdiction of the Commission to include all of the Sacramento and certain other important rivers. The work done has been inspected and approved by Major W. H. Heuer, Engineer Corps U. S. A.

RAILWAYS AND IRRIGATION IN INDIA are contrasted by a recent writer in "Indian Engineering," who considers that in view of the industrial and climatic conditions of the country, far too much money has been expended on railways, and too little on irrigation reservoirs and canals. About 80% of the population is composed of agriculturists and field laborers, wholly dependent upon a proper water supply to enable them to carry on their industries profitably. For this reason, a water storage and distribution system should be established to develop the useful labor of the population, before a railway system is established to handle the products of the population. He instances the experience of the Godavery District, where, within 50 years, the population has been raised from a state of destitution to one of affluence by a wholesale supply of water to their lands. If similar works had been executed throughout the country the railways would now have a much heavier traffic and larger revenues, due to the industrial development and improvement. The long droughts and their terrible results are pointed out, and it is stated that if it is considered advisable to store water in a country like England, it is even more necessary in a country like India, where droughts prevail for six or eight months, and cause famines which are responsible for the misery and death of thousands of people. Little or no industrial progress can be looked for as long as man and beast have enough to do to eke out a bare existence on the scantiest possible supply of food and water.

THE NEW EAST RIVER BRIDGE is progressing as follows: The New York tower foundation is practically complete and the foundation at the Brooklyn end will be finished about Jan. 20. The anchorage on the New York side is progressing and that on the Brooklyn side about one-third completed. There is still some dredging to be done on the New York side. The steel towers have not yet been contracted for owing to the decision of the Corporation Counsel, last February, that the money on hand was not sufficient to warrant such contract. The bids received were returned sealed. But an award will probably be made in February next, and erection may begin about August.

THE MEMORIAL BRIDGE PROJECT, to connect Washington, D. C., with the Arlington Estate, is again being pushed by its advocates, in the hope that the House Committee on Interstate and Foreign Commerce may be induced to report it favorably. This bill has passed the Senate three times, but has always failed in the House. The estimated cost is $600,000, and one of the arguments advanced in its favor is that with this bridge built a large part of the 1,175 acres at Arlington could be placed at the disposal of the Department of Agriculture, to be utilized in agricultural experiments.

THE COST OF ADIT-DRIVING, in the Melones Mine, Calaveras Co., California, is noted by Mr. W. C. Ralston in a paper presented at the Buffalo meeting of the American Institute of Mining Engineers. The adit, or tunnel, was 2,608 ft. long and 7 x 8 ft. in the clear, with a grade of 3 ins. per 100 ft. The drilling was done by an Ingersoll-Sargent Class B compressor and three Ingersoll Eclipse drills; the compressor was run by a pulley and belt on a main shaft connected with a 5-ft. Pelton wheel, under a head of 470 ft. in a 10-in. pipe-line 1,100 ft. long. The effective pressure was 200 lbs. per sq. in. The heading was partly timbered,and the rock was greenstone (diabase), brown slate and talc schists filled with quartz stringers. The working force included 29 men, divided into three 8-hour shifts of 7 men each. No. 2, 40% Hercules powder was used throughout; and after each blast water, under 200-lbs. pressure, was freely used in condensing the fumes and cooling the atmosphere. The total cost of repairs and extras for the compressor, after 8½ months of almost continuous running, was $21.32; and the total cost for extra parts for the three drills was $91.65. The writer then gives the detailed cost of this tunnel.

Actual Cost (Exclusive of Management) of 2,608.5 ft. of Tunnel and Drifts, 7 by 8 ft., up to Sept. 24, 1898.

		Cost per lin. ft.
Labor pay-roll (including timbering)...	$19,501.46	$7.47
Powder. 2,000 lbs., No. 1, at 16.6 cts., 25,550 lbs., No. 2, at 11.9 cts.........	3,405.65	1.30
Fuse, 74,000 ft., at 51.7 cts.............	....	..
Caps, 200 boxes, at 60 cts...............	500.20	.19
Wood, 333½ cords, at $5.00..............	1,667.50	.63
Water, 15 cts. per in., 40 ins. and tender	828.50	.32
Coal, Cumberland, 11,591 lbs., at $15 a ton and freight	179.43	.06
Foot-planks and ties and 9 sets timbers, 8,466 ft., at $20 per M...............	169.32	.06
Candles, 3,040 lbs., at 7½ cts.........	262.04	.10
Steel rails, 21,555 lbs., 1¼ cts. & 2¾ cts.	567.62	.22
Air-pipe, 11-in., 18 cts. and 30 cts., 3-in., 22 cts	....	..
Water-pipe, 2-in., 11¼ cts.............	1,042.45	.45
Horse feed, hay, 1½ cts.; barley,.019 cts	267.16	.10
Steel, drill-parts, oil, tools, etc.........	316.92	.12
Total	$28,708.25	11.02
Actual cost per running foot		$11.02

The air- and water-pipes used in running different cross-cuts were not left in place, but were moved from one to the other; hence the small cost of this item per foot.

LOWRY ROUND COTTON BALES, to the number of 1,000, containing 250 lbs. each, arrived at Charleston,S.C., from Augusta, Ga., on Jan. 6, en route to Genoa. The only objection made by shippers was the difficulty of sampling the bale; the cotton must be accepted largely in faith. The round bales were very easily handled by the longshoremen, though they were very heavy for their size; there was also a great saving in freight room and an immense saving in waste, stealage and tear. This is the first important shipment abroad of the round bales of this type.

ANNUAL MEETING OF THE CONNECTICUT SOCIETY OF CIVIL ENGINEERS AND SURVEYORS.

The fifteenth annual meeting of the society was held at Hartford, on Jan. 10. The meeting was called to order by the President, Mr. R. A. Cairns. The report of the Secretary, Mr. Geo. K. Crandall, showed a present membership of 80, and a cash balance of $437. Ten new members were elected during the meeting.

The President stated in his address that in societies like this he believed in rotation of office, except in the case of the secretary and treasurer. Where the officers are continued from year to year the whole responsibility for the work of the society remains with a few men, and the benefit of rivalry between succeeding officers is lost. The advertising in the last annual report more than paid the cost of publishing the report. Engineering work during the year was dull. The promise for 1899 is brighter. On the New York, New Haven & Hartford R. R. the third-rail electric tracks were extended so they now reach from Bristol to Hartford, a distance of about 18 miles. At Brantford contracts for pipe laying for a new water-works system were let in 1898 at prices ranging from 25 to 14¾ cts. per ft. for 12 to 4-in. pipe, with $2 extra for rock excavation. During the past year increased interest in the prevention of stream pollution has been shown. The great drawback to the work in some localities is the expense, which would entail a financial burden that would hinder development in other lines.

The election of officers for the ensuing year resulted in the selection of Mr. Edwin D. Graves, of Hartford, as President, and Mr. Geo. K. Crandall, of New London, as Secretary, the latter being re-elected. The first paper to be read was by Mr. E. D. Graves, "A Study of the Construction of the Park St. Bridge at Hartford." It described the bridge in detail, including a full copy of the specifications and carefully prepared items of cost. The bridge is a masonry arch, and replaces an old wooden highway bridge. It has a clear span of 54 ft., with a rise of 7½ ft. The total width is 70 ft., and the length over all is 100 ft. The arch proper is of brick, faced with stone. The brick ring is 3¼ ft. thick at the crown and 4½ ft. at the springing line. The abutment foundations are of piles, filled in at the top with concrete. The piles were 50 ft. in length, of oak and chestnut and a little spruce. They came from Guilford, Conn., and cost 9 cts. per lin. ft., delivered at the work, 1,500 ft. from the railway. The piles cost $8.80 each in place. The concrete, of which there was 376 cu. yds., cost $5.40 per cu. yd., in place. The stone skewbacks cost $21.48 per cu. yd., in place, of which $13.82 was for cutting. The waste amounted to 40% of the rough stone. The ring stones, in place, cost $20.36, of which $14.11 was for cutting. The waste was 20%. Ashlar masonry cost about $9.50 per cu. yd., in place, and rubble $5.32, but the latter was mostly built of stone from the old abutments. About 250,000 brick were used for the arch proper, costing $6 per M, delivered at the work, and $12.40 in place, or $7 per cu. yd. The roadway is paved with asphalt. The bridge is now practically completed. Its total cost to the city will be about $27,100. The records and estimates show that the contractor, after adding extras to the contract price, will have about $900 for his own time for some nine months and for transporting his plant to and from New York.

A 30-in. water main is carried across the bridge, being supported on a steel girder, built into the brickwork. Mr. Graves was Consulting Engineer for the bridge and Mr. C. H. Bunce was City Engineer. The contractor was Mr. H. J. Mullen, of New York. Mr. Paul B. Davis was Resident Engineer.

The next paper was by Mr. Arthur J. Patton, on "The Surveyors' Interest in the Land Record Office." The author of the paper called attention to the importance of the surveyor's work and of proper land records. Of ten cities in Connecticut only three make anything like adequate provisions for land records. The statutes provide that record maps may be filed with deeds, but not that they must be. One of the cities of the state has voluntarily established an adequate record office, with maps properly made, indexed and filed for each deed recorded.

Mr. T. H. McKenzie read a paper on "Sewage Purification at Norfolk, Conn." The place is a summer resort with a population of about 2,500. The sewers are on the separate plan, there being about six miles of 8 and 6-in. pipe. The sewage will be treated by intermittent filtration on about 1¾ acres of land some 1½ miles below the village, bordering on Blackberry River. The beds were about half completed before cold weather set in. They are on coarse gravel, the latter being about 7 ft. above the river. The beds are in terraces, with a ditch above to divert surface drainage. They will be 4 to 5 ft. deep, underdrained. Settling tanks were designed, but will not be built for the present. The sewers show but little leakage, the infiltration in six miles giving a flow about 1 in. deep in the 12-in. outlet. At the conclusion of this paper Mr. M. N. Baker, of the editorial staff of Engineering News, made a few remarks, by request, reviewing briefly the septic tanks and so-called bacterial filter experiments in England.

The concluding paper was by Mr. L. W. Burt, who described a "Noteworthy Experience in the Construction of the Main Outlet Sewer at New Haven, Conn." The work was done some 13 years ago. A horseshoe-shaped brick sewer about 7 ft. in diameter was laid across City Point and some 500 ft. into the harbor. The land near the outlet is a mud flat, which at times dams up the natural flow of ground water into the harbor. The resulting pressure broke up through the invert of the outlet at the junction of two construction sections, some distance inland from the water line. This occurred just after the junction was made. Repairs were made by damming the water each side with sand bags, lowering a diaphragm pump through a manhole and pumping and bailing the water out. The loose material was removed and 4 x 12-in. bags of equal parts of Portland and Roman cement, wet with hot water, were used to form a new invert, clamped down with a form braced from above and allowed to set before the form was removed. The invert here was 4 ins. of brick on concrete 2 ins. thick at the base of the invert, the whole being on a 12-in. timber grillage.