ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Vol. XXXIX., No. 2.

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THE NEW YORK DRY DOCK NO. 3 has been sufficiently exposed, under the work of Naval Constructor Bowles, to show the true cause of failure. The chief trouble is found in the sheet piling of the coffer dam near the entrance. The specifications called for 8-in. sheet piles driven tightly together for a depth of 47 ft., or until hard bottom was reached. Mr. Bowles finds that some of these piles simply rested on the mud and others were driven from 4 ft. 4 ins. to 17 ft. into this mud, but allowed water to enter beneath them. Other piles were out of line, overlapping, or twisted out of shape and position in driving. Some of the concrete is said to be shallow in depth and inferior in quality. The whole work, so far uncovered, is characterized as outrageously bad, showing rascally scamping of work on the part of the contractor and culpable negligence on the part of the inspectors. The history of this work is briefly as follows: The contract was first let in November, 1892, but the contractor did not undertake the work and the contract was relet to John Gillies, of New York, for $412,000; Gillies failed to make the required progress, and in May, 1895, Secretary of the Navy Herbert let the work remaining to be done to T. & A. Walsh, of New York, for $370,000. Under this latter contract the faulty work above noted was performed, Mr. A.G. Menocal, C. E., U. S. N., being the government engineer in charge. The dry dock was accepted as complete in March, 1897, with a total cost to the government of $555,033. The new dock was tested by the admission of the monitor "Puritan," and then by the battleships "Iowa" and "Massachusetts" successively. Excessive leakage was developed and the latter ship was hurried out in time to escape possible material damage. Investigations followed and Congress finally appropriated $100,000 for repairs, in June, 1897, and Naval Constructor Bowles was put in charge. The damage was at first charged to the operations of a dredge in lifting and breaking some of the sheet piling at the entrance; but this is disproved by the emptying of the dock, made possible by the building of a strong coffer dam around the entrance. The additional sum of $50,000 is now asked for to continue repairs and the prospect is that much more will be required before the dock is made perfectly safe. The report of Mr. Bowles is fully sustained by the late report of a board made up of Naval Civil Engineers P. C. Asserson, M. T. Endicott and Mr. F. T. Chambers. An explanation has been officially demanded of Mr. Menocal, who is now in Nicaragua with the Canal Commission. Since the above was written other and even more serious defects have been developed in this dock. Water is finding its way through the piling under the east entrance wing wall and inside of the coffer dam constructed by Mr. Bowles. This last leak is carrying quantities of fine sand and the surface ground has sunk about 18 ins. under the armor-carrying track near the dock entrance. As one result of this settlement the dock coping is showing a widening crack, indicating a movement outward of the caisson abutment. As an evidence that it was known by some one that the lines of 8-in. tongue and grooved sheet piling, across the dock entrance, were originally out of line, irregular and badly driven, it is now found that the timber floors at this point were carefully cut to fit these irregularities. The Navy Department is urging Congress to provide the means for meeting this emergency, which may possibly mean the reconstruction of a large part of the new dry dock.

THE RECENT ACCIDENT TO THE BATTLESHIP "Iowa" illustrates one of the effects of the modern intricacy of construction and design in the batteries of battleships, following their increase in power and quickness of handling. During a sea-test of the 12-in. guns, for rapidity of fire with smokeless powder, at the sixth shot the dashpot, used to relieve the cylinders in recoil, broke and fell, disabling the gun completely. This dashpot weighs about 500 lbs., and while the damaged part can be easily restored in a navy yard, if it breaks in action the warship is practically at the mercy of the enemy. Naval officers call for a thorough investigation of this part of the gun's equipment, and a new device that will be safer and more durable under the strain of service.

◆

THE COST OF A 30-FT. CHANNEL IN THE DELAware River, as an entrance to the port of Philadelphia, is estimated at $5,935,000 by Major C. W. Raymond, Engineer Corps, U. S. A., in charge. This includes the cost of deepening the 26-ft. channel at low water, nearly completed, and for a width of 600 ft., from Petty Island to deep water in Delaware Bay. Of this amount $644,000 is for the removal of rock at Schooner Ledge and near Cramp's ship yard. The estimated quantity of material to be removed is about 32,375,000 cu. yds. of mud and clay and 60,000 cu. yds. of rock. The deeper channel is strongly urged by the Philadelphia Board of Trade and business interests generally. The estimated time of completion is six years.

◆

OCEAN TRAVEL FOR 1897 shows a decrease in westbound cabin and steerage passengers. The figures for 1897, as compiled by Mr. Wm. C. Moore, landing agent at New York, show 90,332 cabin passengers landing in 901 trips, as compared with 99,223 in 1896, coming in 852 trips. The steerage passenger list, in 1897, numbered 192,004; as compared with 252,350 in 1896, 258,560 in 1895, 188,164 in 1894 and 364,700 in 1893.

◆

GERMANY'S COMMERCE, says U. S. Consul Walter Schumann, of Mainz, has increased in the last few years as follows: In 1881 the foreign trade of Germany amounted in value to $1,508,206,000; in 1895 it was $1,772,624,000, an increase of $264,418,000. That this is not due solely to the general increase in the world's commerce is shown by the fact that in this same period England's commerce decreased by about $190,400,000; that of France decreased by about $142,800,000; that of Russia by about $71,400,000. During 1881-1893, Germany's commerce with the United States increased from $83,300,000 to $190,400,000; with Brazil, from $3,570,000 to $44,506,000; with the Argentine Republic, from $8,806,000 to $36,414,000; with Chili, from $2,142,000 to $25,000,000; and with British India, from $5,117,000 to $53,800,000.

◆

THE UNITED STATES EXPORT TRADE, for the eleven months ending with November, 1897, is given as follows from the official figures at Washington, compared with the same period of the previous year:

Products.	1896.	1897.
Agriculture	$578,692,078	$635,782,489
Manufacturing	229,915,258	256,256,812
Mining	19,638,218	18,233,839
Forestry	33,142,795	37,868,468
Fishery	5,975,007	5,223,838
Miscellaneous	3,379,566	3,310,428
Totals	$870,742,922	$956,675,874

◆

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred Jan. 7 at Harvey, Ill., on the Grand Trunk Ry. According to reports, a suburban train had only a few minutes previous been shunted upon a siding. The switch must have been left open, for the following train, a freight, ran on the siding, injuring three men, two of them fatally.

◆

THE BURSTING OF A DRIVING WHEEL TIRE of a locomotive drawing the Royal Blue line train over the Central Railroad of New Jersey, at Netherwood, N. J., Jan. 9, injured the fireman and two passengers. At the time of the accident the train was running about a mile a minute, but no derailment occurred.

◆

THE BOILER OF A TOWBOAT EXPLODED on the Ohio River, near Glenfield, Pa., Jan. 8. Reports state that 7 men were killed and 9 injured. The cause is not known.

◆

BURGLAR-PROOF MAIL CARS have been built at the Topeka shops of the Atchison, Topeka & Santa Fe Ry. They have no end platforms, and the doors are fitted with heavy bolts, bars and chains, while the windows and ventilators are fitted with bars. A secret receptacle has been provided for the safe carriage of registered letters. Besides these precautions against the entry of unauthorized persons, the cars in equipment and finish are model railway postoffices. An extra amount of table room has been provided, the letter cases have patent roller label holders, and wire bottoms. The cars are lighted with seven Pintsch gas lamps and there are fittings for temporary lights in case of emergency. The cars are 60 ft. long and were built after designs furnished by the postoffice department.

◆

THE RAW MATERIALS REQUIRED FOR A LOCOMOTIVE have been ascertained for a typical 8-driver freight locomotive of the London & Northwestern Ry. by Mr. F. W. Webb, its Locomotive Superintendent, and the list as published in London "Engineering" is as follows:

	Lbs.
Coal	118,800
Steel scrap	63,043
Pig iron	54,215
Scrap, wrought iron	16,352
Swedish iron	14,448
Copper ingot	11,137
Coke	10,304
Spiegel	6,373
Cast-iron scrap	3,403
Limestone	2,045
Block tin	546
Lead	83
Tile zinc	76
Phosphorus bronze	70
Ferro-Manganese	132
Red ore	120
Chrome	80
Aluminum	13
Antimony	4

The aggregate is nearly 139 tons for a complete locomotive weighing about one-third of this total.

◆

FORGED STEEL CAR WHEELS, manufactured by the Facer Forged Steel Wheel Co., at Perth, Ontario, Canada, are made of solid steel ingots, the hub, plate center, tire and flange all being forged from one piece. The process is as follows: A round steel ingot, about 18 ins. in diameter and 13 ins. thick, weighing about 900 lbs., is heated in a suitable furnace. It is next placed under a steam hammer and flattened into a disk about 6½ ins. thick and 26 ins. in diameter. Next it is turned upon edge and the flange forged by means of dies with a V-shaped groove. The hammering necessary for the flanging reduces the diameter of the disk, and another set of dies thin up the wheel and form the hub and punches the hole. Another hammering thins out the web and fits the wheel for boring and facing.

◆

THE SYSTEM OF FILLING LOCOMOTIVE TENDER tanks, described in our issue of March 26, 1896, has been awarded medals at several recent expositions in Europe, is on trial on the Hungarian State Railways, and has been recommended for general adoption on the lines controlled by the Italian government. The system is the invention of Coda Costa, Chief Engineer of the Mediterranean Division Ry., with headquarters at Civitavecchia, Italy.

◆

STATISTICS OF RAILWAY CONSTRUCTION in the United States in 1897 have been collected by the "Railroad Gazette," and the "Railway Age." The construction by states as given by these two journals is as follows:

States.	Miles. "Age."	Miles. "Gazette."	States.	Miles. "Age."	Miles. "Gazette."
Alabama	111.67	114	New Jersey	9.39	10
Arkansas	109.5	84.5	New York	18.95	27.02
California	209.91	192.06	North Dakota	37.5	36.29
Colorado	16	35.33	North Carolina	32.2	52.38
Delaware	25	25	Ohio	6.3	5.28
Florida	17	1	Okla. Ter.	0.8	27
Georgia	119.25	97.45	Oregon	51	31
Idaho	24	24	Pennsylvania	116.47	142.09
Illinois	92.2	116.85	So. Carolina	10.5	10.5
Indiana	0.5	0.0	So. Dakota	1.25	0.
Iowa	8	8	Tennessee	22	15
Kansas	0	1.73	Texas	103.6	97.45
Kentucky	7	20.35	Utah	1	0
Louisiana	145.3	129.5	Vermont	3.25	3.25
Maine	30.55	19.35	Virginia	6.5	19.65
Massachusetts	5.25	5.26	West Va	55.95	51.5
Michigan	133.36	125.74	Wisconsin	115.65	90.8
Minnesota	4.72	42.82	Washington	1	0
Mississippi	89.5	55.9	Ind. Ter.	0	0.8
Missouri	110.5	93.2			
Dist of Col	0.0	2	Total	1827.92	1864.52
Montana	12	13.9			

In addition to the total given the "Gazette" estimates that about 110 miles of track have been laid on roads where tracklaying was in progress when the figures were compiled.

◆

THE BOSTON SUBWAY WORK is nearly completed. The Boston Transit Commission, in its annual report, says that the work still to be done lies in the section in Scollay Square, the section in Adams Square and the section north of Haymarket Square. Chief Engineer Howard A. Carson reports that 87% of the whole work is finished and 7% more is under contract or ordered. According to present prospects the total cost of the improvement will fall considerably within the engineer's estimates. The total cost of the subway to date is $4,043,313.17; the original estimate being $5,000,000. A tunnel under the harbor to East Boston is again being discussed at an estimated cost of $2,406,600.

◆

THE BIDS FOR THE EIGHT-TRACK DRAWBRIDGE over the Chicago drainage canal were given in our issue of Dec. 30, 1897, but it should have been stated that the bid of $254,000, made by Mr. C. L. Strobel, included both substructure and superstructure.

◆

THE MICROSCOPIC STUDY OF STEEL is being put to practical use in the investigation of a recent locomotive boiler explosion to determine whether the explosion was due to low water. The water line in the boiler at the time of the explosion is to be determined, if possible, by microscopic study of sections taken from different parts to detect evidence of overheating.

AN ELECTRIC FREIGHT LOCOMOTIVE

As briefly mentioned in our last issue the formal opening of the Hoboken Shore Road, Hoboken, N. J., occurred Jan. 4. This road, some two miles in length, forms a connecting link between the tracks of the various railways terminating in Hoboken and the docks and warehouses extending along the Hudson River from Hoboken to Weehawken. For the past three months freight cars have been handled by an old electric repair car impressed to do duty as a locomotive, but on the date mentioned a modern electric locomotive, built by the General Electric Co., at Schenectady, N. Y., was set to work in the presence of a number of invited gentlemen. The machine is shown in Fig. 1 as it appears in actual operation and is in general design similar to the locomotives built by the same company for the Baltimore & Ohio R. R. and now in daily use in Baltimore, Md.

FIG. 1.—A 540-H.P. ELECTRIC FREIGHT LOCOMOTIVE.
General Electric Co., Schenectady, N. Y., Builders.

The cab is of sheet iron, as are also the sloping tender shields at each end, and is almost square. Each side is provided with two drop windows affording an unobstructed view in all directions, while suitable sliding doors on the sides are also provided. The interior of the cab is finished with cherry and all fittings are of polished brass or nickel. On the top of the cab is the usual trolley base and pole. On both the sloping shields are placed head lights and just back of these are the usual whistle, on one end, and bell on the other. At the front and rear end a small platform and railing will be noticed, intended for the brakeman in charge of the trolley pole, for use when coupling cars. Suitable automatic couplers, buffers, air pipe connectors and wheel fenders are mounted upon the locomotive frame, leaving the trucks entirely free, as in the case of standard railway cars. The compressed air tank, equalizing air tank, two sand boxes and four resistances built of German silver ribbon wound upon asbestos and packed between sheets of asbestos are placed under one shield, while under the other are located 8 similar resistances, two more sand boxes and a suitable box for tools. The length of the body from platform to platform is 29 ft., the width 8 ft., height to trolley base is 13 ft., a distance from center to center of trucks 12⅝ ft., and the total weight is 57,000 lbs.

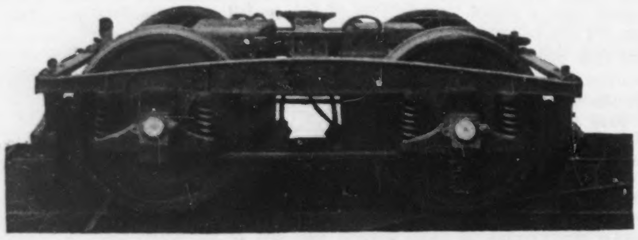

FIG. 2.—SIDE VIEW OF LOCOMOTIVE TRUCK.
Showing simplicity and small size of motors.

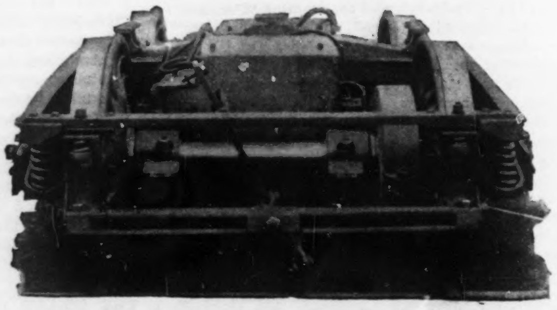

FIG. 3.—END VIEW OF LOCOMOTIVE TRUCK.
With 2 G. E.-2,000 motors—85 rated H.P. each.

In the interior of the cab and at one side is a single cylinder vertical air compressor driven by a 3 HP. bipolar, slow speed, iron clad motor taking current from the trolley and operated automatically by a governor switch, which turns on current when the air pressure drops below a certain point and cuts it off when it exceeds a certain value. At the opposite end of the cab is placed the controller corresponding to the throttle of a steam locomotive. This is technically known as an L-2 type series-parallel controller and is arranged to operate the four motors in series or in two sets of two in multiple series. In plain sight of the motorman is a line ammeter of 500 amperes capacity, while just below is an air brake gage of the usual type. Overhead is a Type L automatic magnetic blowout circuit breaker adjusted to 500 amperes and series with the main circuit. Besides the controller and within easy reach of the operator is the usual engineer's valve for the air brake and two valves operating a blast arrangement, which causes sand to be blown under the drivers. Near by is also another circuit breaker in series with the air pump motor and the automatic governor already mentioned.

The locomotive is provided with two four-wheel trucks shown in Figs. 2 and 3. To each axle is geared a G. E. 2,000 motor of 85 rated HP., making a total of 540 HP. for the four, and a draw bar pull of about 10,000 lbs. Slow speed motors and a single reduction of a very low ratio give a speed, when fully loaded, of about 8 miles per hour. The wheel base of each truck is 5½ ft. and the compact and simple construction of the trucks as well as the small size of the motors is well shown in Figs. 2 and 3.

In the test of Jan. 4 a train consisting of 8 standard freight cars fully loaded and weighing about 295 tons was moved with ease.

At present current for operating the locomotive is supplied directly to the No. 00 trolley wire by the Hudson Electric Co.

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THE SEPTIC TANK SYSTEM OF SEWAGE TREATMENT AT EXETER, ENGLAND.

By Albert S. Crane.*

Since the Local Government Board of Great Britain has taken the stand that the purification of sewage effected by chemical precipitation is insufficient and is compelling nearly all the cities using that system alone to supplement it by further purification, various new methods have been devised.

Among the many schemes of sewage disposal now agitating the minds of English sanitary engineers the method invented and patented by Donald Cameron, City Surveyor of Exeter, is perhaps attracting the most attention. Although it has not yet received the sanction of the Local Government Board, which is still wedded to sewage farming and intermittent filtration, the interest shown in it and favor which it has found with engineers cannot fail to cause that board to pass upon it. The writer in a recent trip through Great Britain, inspecting sewage disposal works, found many towns anxiously looking to the septic tank system as a relief.

The plant at Belle Isle, Exeter, was put in use on Aug. 16, 1896, and since that date has been purifying the sewage from about 1,500 inhabitants. It consists of two parts, the septic tank, in which the anaerobic bacteria act upon the sewage and prepare it for the second part, which consists of five filter beds in which the aerobic bacteria complete the purification.

The septic tank is a reservoir made of concrete, built in the ground, arched over and covered with sod. It is 64 ft. 10 ins. long, 18 ft. wide and varies in depth below the sewage line from 7 to 7¾ ft. This tank is dark, air-tight and has a capacity of about 65,000 U. S. gallons. At the inlet end of the tank are two small grit chambers 10 ft. deep below the sewage line, separated from the rest of the tank by a wire, and so arranged that one may be used at a time. The sewage enters the grit chamber near its bottom and comes in with a considerable velocity, owing to the reduced size of the inlet pipe on the tank side. This velocity scours the heavy materials in the grit chamber and prevents any undue amount of organic matter from lodging there. The sewage, then relieved of sand and grit, rises and passes over the weir with greatly reduced velocity into the tank proper. The tank is designed to hold about one day's supply of sewage, which gives the bacteria time to work upon it. In the center of the tank is an inspection well with glass windows in the sides through which the working inside the tank may be watched. A sketch plan of the tank and adjacent filter beds is shown by the accompanying illustration.

At the time of the writer's visit, in the latter

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*Of the Department of City Works, Brooklyn, N. Y. Mr. Crane's article has been supplemented with later information from the English engineering papers, as noted.

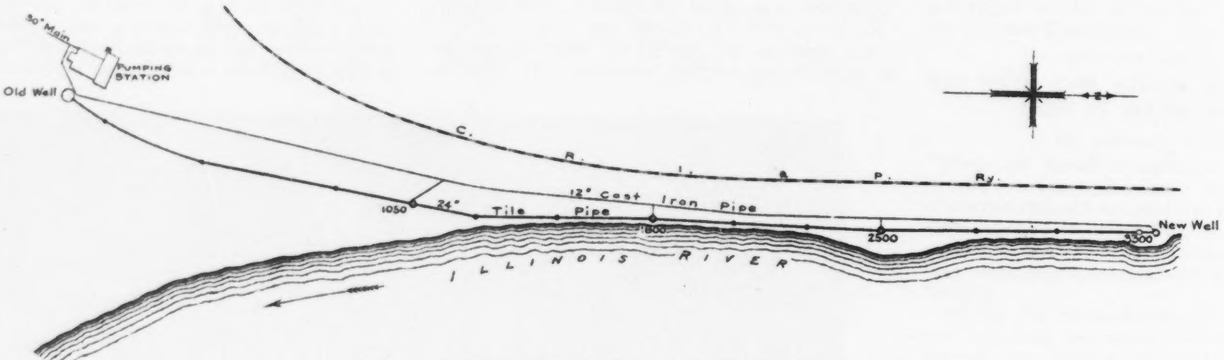


FIG. 1. PLAN SHOWING LOCATION OF WELLS AND PIPE LINE.

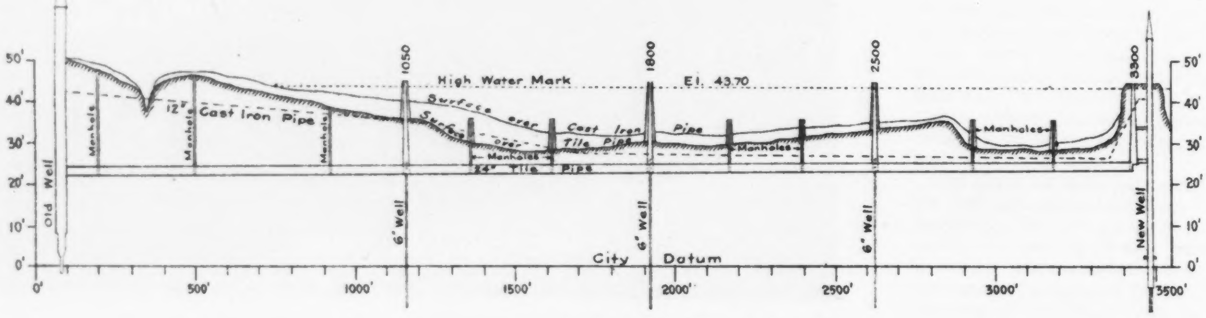


FIG. 2. PROFILE OF PIPE LINE.

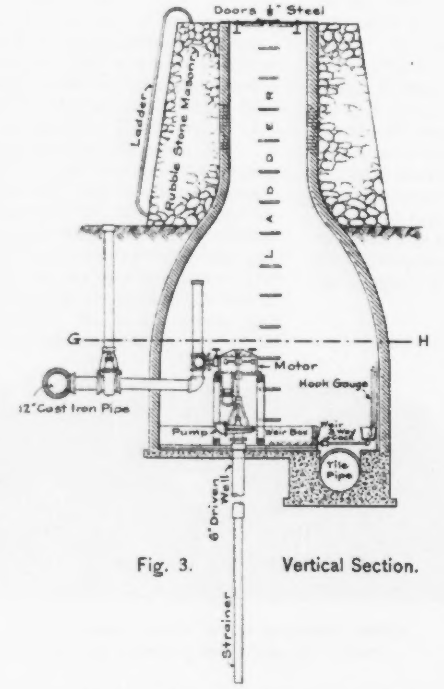


Fig. 3. Vertical Section.

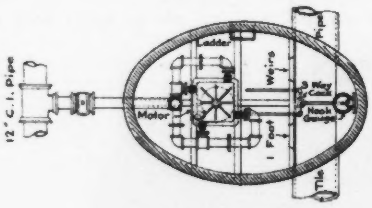


Fig. 4.
Horizontal Section at G-H.

FIGS. 3 AND 4. SECTIONS OF VAULT SHOWING PUMPING PLANTS AT SECONDARY WELLS.

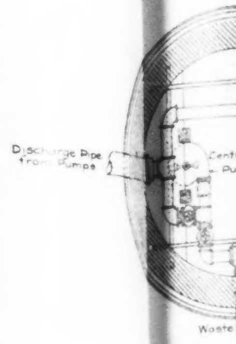
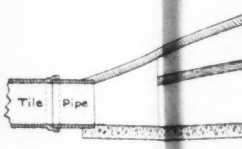


Fig. 5. Horizonta



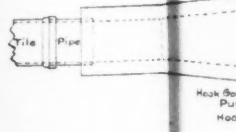


Fig. 8. H

SUPPLEMENTAL PUMPING PLANT OF THE

Dabney H. Maury, Jr., M. Am. Soc. M

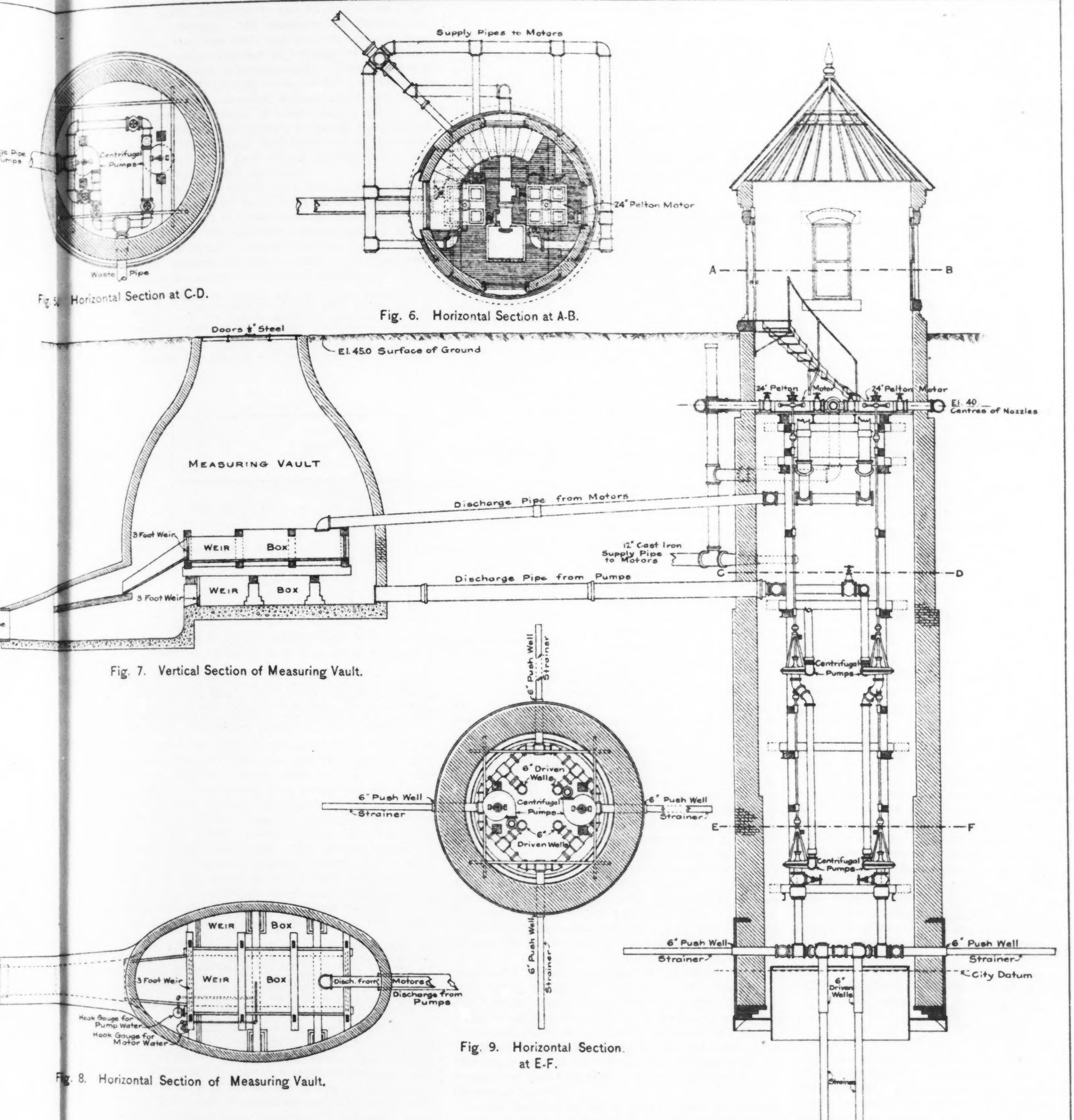


Fig. 5. Horizontal Section at C-D.

Fig. 6. Horizontal Section at A-B.

Fig. 7. Vertical Section of Measuring Vault.

Fig. 8. Horizontal Section of Measuring Vault.

Fig. 9. Horizontal Section. at E-F.

Fig. 10. Vertical Section of Main Well.

FIG. 5 TO 10. SECTIONS SHOWING PUMPING MACHINERY AND MEASURING VAULT AT MAIN WELL.

ANT OF THE PEORIA WATER CO., PEORIA, ILL.

M. Am. Soc. M. E., Designing Engineer.

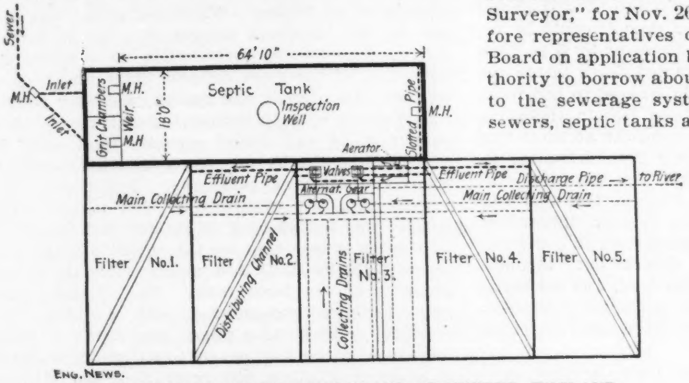
CHAS. HART & SONS, LITH., 36 VESEY ST., N. Y.

part of August, there was about 6 ins. of thick, dark brown scum on top of the sewage, and from 6 to 12 ins. of sediment on the bottom of the tank. Mr. Commin, Surveyor to the Patentees, and Mr. Martin, Assistant City Surveyor of Exeter, assured me that the tank had been in constant use for over a year, treating an average of about 60,000 U. S. gallons of sewage daily. From analyses made by W. J. Dibdin, Chemist to the London County Council, the crude sewage contained about 24.5 grains per gallon of suspended matters, and the tank effluent 10.8 grains per gallon, so that 13.7 grains per gallon must have remained in the tank. This quantity in a year would represent over 180 tons of sludge of 90% moisture.

Dr. Rideal, in a paper read Dec. 9, 1896, before the Sanitary Institute of Great Britain, estimated the daily amount of solids entering the tank at 400 lbs., and that the minimum time required to fill up the tank would be nearly three years.

In the "Lancet" of Dec. 5, 1896, a correspondent describes the action in the tank as follows:

> Soon a bubble is formed and the little fragment is buoyed up to the underside of the crust at the top of the tank. Now the bubble gradually squeezes its way through this crust and bursts under the dome of the tank. The little particle, having lost its airy support, falls once more down to the bottom. But so sure as it contains organic matter this particle will be fastened upon by some more micro-organisms. Another bubble will be formed; it will be carried up to the top of the tank again, and the process will be repeated till all the organic matter has been consumed and dissolved and there remains nothing but ash—inoffensive mineral ash—on which the microbes cannot feed. The deposit is very fine and inorganic.



SKETCH PLAN OF SEPTIC TANK PLANT AT EXETER, ENGLAND.
Taken from a sketch by F. J. Commin, Surveyor to Patentees, Exeter.

On top of the tank is a burner from which the gas generated in the tank may be burned. The flame is odorless, almost without color, and the gas, before burning, has only a slight musty smell.

The sewage, having been acted on for nearly 24 hours in the septic tank, is taken out through a slotted pipe, which is about 16 ins. below the top of the sewage in the tank. The effluent runs over an aerator in a thin film and passes to the filter beds. At this stage it has a very slight musty odor, a light yellowish color, and contains large quantities of small dark flocculent masses.

Mr. Dibdin, in a report made July 5, 1897, said:

> By the biological action in the septic tank itself the organic matter in the sewage was so changed that the amount of oxidizable organic matter in solution was reduced by 30.8%; the free ammonia by 26.9%; and the albuminoid ammonia by 17.5%; and the suspended solids by 55%. The condition of the organic matter remaining was also changed, rendering it more easily broken up."

The filter plant in which the purification is continued consists of five beds of 720 sq. ft. each, and 5 ft. in depth. They are made water-tight and are filled with coke breeze and crushed cinders. One of the beds is always resting for a week at a time. They are operated as follows: By a patented automatic arrangement the effluent from the septic tank is first let into Bed No. 1. After this is filled, the effluent runs through a small pipe, shuts itself off from Bed No. 1, and begins to run on Bed No. 2. When this in turn becomes filled, the effluent goes to Bed No. 3, and so on around. In each bed the sewage remains about two hours, when the valve in the underdrain is automatically opened and the effluent passes out. Each bed in its turn rests two hours.* The operation is continuous, and is done without the assistance of an attendant. During the first rush of the effluent it is very slightly colored, but soon becomes remarkably clear and entirely free from odor.

Mr. Dibdin also reports that:

> The result of the work done by the united processes of septic tank and coke breeze filters was an average diminution of dissolved oxidizable organic matter equal to 80.9%; of free ammonia, 54.9%; and of albuminoid ammonia, 63.2%, and practically the whole of the suspended matter was removed. Nitrous and nitric acids were also formed, the consistent manner of their production showing the satisfactory conditions of work obtaining.

The City Surveyor has prepared plans for disposing of the sewage of the whole city. The population to be cared for is 47,000, for which he proposes to use 37,000 sq. ft. of septic tank, and about 2½ acres of filter beds.

Since Mr. Crane's article was submitted we have received additional information regarding the above plant, and also further particulars regarding the proposed works for treating the sewage of the whole city. This information consists of a paper by Mr. Cameron, the inventor of the system, entitled "A Year's Experience of the Septic Tank System of Sewage Disposal at Exeter," read before the recent meeting of the Sanitary Congress, at Leeds, England, and published in "The Contract Journal" for Oct. 13, 1897; also of a report in "The Surveyor," for Nov. 26 and Dec. 3, of a hearing before representatives of the Local Government Board on application by the City of Exeter for authority to borrow about $195,000 for improvements to the sewerage system, including intercepting sewers, septic tanks and accompanying filter beds and land for sewage irrigation. From this last it will be seen that land treatment is proposed in connection with the septic tank system. This we understand the Exeter authorities claim to be unnecessary, but it seems they think it wise to defer to the well-known conservatism of the Local Government Board; and, besides, provision must be made for treating the storm flow.

Mr. Cameron opened his paper by stating that the Exeter tanks were designed as permanent works to treat a maximum of about 98,000 U. S. gallons of sewage daily, from the St. Leonards outfall sewer, superseding an experimental plant tried for some months. During the drouth of 1895 the minimum flow of sewage reaching the tanks was 42,000 U. S. gallons, the average for the first 25 days of August, 1896, being about 45,600 U. S. gallons. During the latter half of February, 1897, the average daily flow was about 99,000 U. S. gallons. For the year ending about the middle of August, 1897, the total quantity of sewage treated was, in round numbers, 24,000,000 U. S. gallons, being 371 times the capacity of the tank, and an average of about 66,000 gallons a day.

Mr. Cameron states that the net loss of dry solid matter for the whole year was about 26 long tons, or 81% of the whole. He accounts for this as follows: (1) Minute particles of suspended matter pass to the filters, but they do not clog the latter. (2) A great part of the carbon and hydrogen of the organic matter combine with the oxygen of the same and pass out as carbonic acid gas and water. (3) Methane or marsh gas forms and collects in the upper part of the tank; free hydrogen and nitrogen are also liberated, but no sulphuretted hydrogen is found.

In the hearing on the proposed loan, mentioned above, the town clerk made the following statement regarding land for irrigation:

> Although the council could have discharged the filtrate into a stream without any injury to the stream, yet they remembered that the Local Government Board some time ago made it known that they would require treatment on land as an essential part of any scheme. The council had, therefore, provided 20 acres of land, and the scheme provided for taking the filtrate on to this land and applying it to the surface of the land by irrigation. Over 16 acres of this land was a natural filter-bed, constructed of coarse gravel, from whence the filtered water would flow off into the river at a place where the river became tidal. This system provided an assurance of the prevention of any chance nuisance.

Mr. Cameron, City Surveyor of Exeter, and inventor of the system, stated that the sewage on coming to the proposed works would first pass through one or all of three grit chambers, each 15 ft. sq. and 15 ft. deep. It would then go to the six septic tanks, each 35 ft. 4½ ins. wide, 181 ft. 4½ ins. long, and 7 ft. deep, having a total capacity of 262,422 cu. ft., or about 1,965,000 gallons, and being covered with concrete arches on brick piers. The tanks may be used independently or collectively. Both the inlet and outlet will be submerged.

From the septic tanks the sewage will go to the eight filters, each with 4 ft. of filtering material and an area of 13,613 sq. ft., or a total of 2½ acres. The effluent from these filters will go to the irrigation area of 20 acres.

Like Worcester, Mass., the outlet sewers at Exeter are old water courses, enclosed with masonry, and like Worcester, also, Exeter proposes immediately to separate the stream flow from the sewage proper. The English city also has the combined system of sewers, but does not propose, like the American, to put in the separate system. With the stream flow excluded, the amount of sewage to be treated at Exeter, allowing for an increase of 10,000 over the present population, is assumed as about 1,275,000 U. S. gallons, for a population of 47,000 tributary to the sewers. The rainfall in Exeter for the past twenty years has averaged 30.875 ins. per annum. The carrying capacity of the new outfall sewer will be about 6,865,000 gallons a day, giving a surplus over the above dry weather flow equal to ¼-in. rainfall in 24 hours over the sewerage area. With the ordinary flow the sewage would remain in the septic tanks for 45 hours, and with ¼-in. rainfall it would remain 7½ hours.

With the ordinary flow of sewage the filtering area will eventually work at the rate of 510,000 U. S. gallons an acre. When rainfall increases the flow to exceed a total of 3,000,000 U. S. gallons, or 1,200,000 gallons an acre, the surplus will be diverted from the filters, just after leaving the septic tanks, and pass to the irrigation area, together with the effluent from the filter beds. The total volume to be applied to the irrigation area will then be 6,865,000 U. S. gallons, or nearly 350,000 gallons per acre, of which nearly half will have had the septic tank treatment, followed by filtration at the rate of 610,000 U. S. gallons per acre.

The sewage to be treated will be mainly domestic, but will include the wastes from two brown paper mills, two breweries and one tannery.

In conclusion, it may be said that the septic tanks as tried at Exeter, are arousing great interest in England, and that some of the leading scientists of that country seem to be greatly impressed with the work done by tanks, although no one, so far as we have seen, has yet made a careful study of the cost of this system as compared with intermittent filtration. We have commented on this and some other new English sewage purification projects in our editorial columns.

The English papers report two explosions as having occurred recently in the observation chamber of the Exeter tank, but give no particulars, except that in one of them Mr. A. Creer, City Engineer of York, "sustained severe burns and a shock to the nervous system," and required medical attendance.

SUPPLEMENTAL PUMPING PLANT OF THE PEORIA WATER CO., PEORIA, ILL.

(With two-page plate.)

By Dabney H. Maury, Jr., M. Am. Soc. M. E.*

In the summer of 1895 the Peoria Water Co. was compelled, in consequence of the unprecedented drouth, and the excessive consumption and waste of water in Peoria, to increase its water supply. The method adopted to secure the additional water is described in this paper.

The pumping plant of the Peoria Water Co. consisted, in 1895, of six 200-HP. Heine water tube boilers; three Worthington vertical compound duplex high duty pumping engines, of 7,200,000 gallons capacity each; and of 100,000,000 ft.-lbs. duty per 1,000 lbs. steam; and the necessary feed pumps, air pumps, jacket pumps, and other auxiliaries. The main pumping engines then took their entire supply from an open well, 53 ft. deep by 34 ft. in diameter, sunk in the gravel near the pump pit, or dry well. The water was, and is,

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*According to the statement made in November, 1897, by the Town Clerk of Exeter, and published in "The Surveyor," of London, the beds are operated in pairs, each bed is six hours in filling; stands full six hours; and then has a rest of about six hours.—Ed.)

*Engineer and Superintendent Peoria Water Co., Peoria, Ill.

pumped against a pressure of about 130 lbs. into the 30-in. discharge main, which leads to the city, an open branch on this main leading up to a 19,000,000 gallon reservoir on the "Bluffs," about a mile west of the pumping station. When the pumps are delivering more water than is being used in the city, the surplus goes to the reservoir. When the pumps are shut down, or the use exceeds the pumping, the reservoir makes up the deficiency. The general location of the original and supplemental pumping plants is shown in plan and section in Figs. 1 and 2.*

Water bearing gravel was known, from previous borings, to underlie the territory surrounding the main well, and lying between the Bluffs and the west bank of the Illinois River. A more careful survey of this gravel was made by means of additional driven wells, 4 and 6 ins. in diameter, which were sunk to bed-rock, and equipped, for test purposes, with short strainers. Samples of the various strata encountered were saved, and an accurate record of borings was kept. The water level in each well was noted, and by means of a series of many such observations, made on some 35 wells distributed at advantageous points, much information was obtained as to the quality and quantity of the underground water, and its surface slope under various conditions of rainfall and pumping. These surveys showed that the best point for a new well was about 3,340 ft. above, or up-stream from, the old one.

Several methods of bringing the water from the new well to the old one were considered. The first plan which naturally suggested itself was the establishment of a separate steam pumping plant at the new well; but the first cost, and the still greater subsequent expenses for engineers and firemen and maintenance, rendered this plan undesirable.

The various types of air lift were next studied; but the cost of the air compressors, and the very low efficiency of the system, and the fact that, in order to get the submergence of the air pipes, requisite for its proper working, wells would have to be sunk 50 to 60 ft. into bed-rock, caused this plan to be rejected.

Electricity was next considered. The large surplus of boiler capacity seemed to render feasible the installation of a generating plant at the pumping station, and of electric motors to drive the pumps at the new wells. The first cost of this system; the necessity of having to employ skilled electricians to run the generator, and the motors at the new wells; the liability of the motors and generator to get out of repair; and the fact that the dampness in the new wells would injure the motors, combined to cause the rejection of this plan also.

The following system was finally adopted. An open well, 11 ft. inside diameter, was sunk 3,340 ft. from the old well. A 24-in. vitrified tile pipe line was laid from near this well, on a grade of 5-100 ft. to 100 ft., to empty into the old well. Parallel to this tile pipe, there was laid a 12-in. cast-iron main, connected with the 30-in. force main. In the new well were erected in duplicate, plants consisting each of two vertical centrifugal pumps, compounded, driven directly by a Pelton water wheel on the same vertical shaft as the pumps. The 12-in. cast-iron main delivers water from the force main at 120 lbs. pressure, to drive the motors. The centrifugal pumps lift the water from the well into the upper end of the tile pipe line, whence it flows by gravity to the old well; while the water used to drive the Pelton wheels is also discharged into the same pipe line, and returned with the pump-water to the old well.

In other words, the surplus power of the high duty main pumping engines is employed to do the work of running the pumps in the new well; and the water, which is used to transmit this power, is returned with the water pumped from the new well to the old one, no water being lost in the operation. The details of this plant as originally constructed in 1895 are shown in Figs. 5 to 9, inclusive.

The tile pipe line was laid with great care, the joints being pointed inside and out, and afterwards smoothed off and brushed on the inside with cream of neat Portland cement. The entire line was afterwards tested for leaks under 2 lbs. pressure, and the leakage was found to be inconsiderable.*

The construction of the entire plant was attended with great difficulties. Quicksand was met in two-thirds of the length of the pipe line. The water supply was dangerously low, while the consumption and waste were larger than ever before, and the work had to be pushed with all possible haste at consequently greatly increased expense. In sinking the well, the excavation was first made as deep as the ground water would permit. The well shoe was then constructed, and the masonry built on as the shoe sank, the sand being excavated under the shoe by manual labor, and the water and some of the sand removed by vertical centrifugal pumps driven by a belt from a steam engine. A separate hoisting engine raised, in buckets, the sand which was not pumped out. The well sunk rapidly, from 2 to 3 ft. per day, to within 12 ft. of bed-rock, when its progress was suddenly diminished, and all efforts failed to get more than 4 ft. further. It was the intention to sink the well to bed-rock, and then to drive out horizontal "push-wells," to collect the water from as large an area at as low a level as possible; but it was found that at 8 ft. from bed-rock the sand ran in under the shoe faster than it could be removed. A steel ring 10 ft. diameter by 5 ft. high by ½-in. thick, was then started down inside the well in the hope that it might be sent to bed-rock, but after much time had been lost in trying to keep ahead of the inflowing sand the attempt was abandoned. Oak wedges were then driven so as to close solidly the space between the ring and the wall of the well, the bottom of the well was closed sufficiently to prevent further inflow of sand, and four driven wells were sunk to bed-rock. Four push wells were also driven out through holes made in the wall of the well, and all eight of these tubular wells were equipped with 6-in. Cook strainers and connected to the suction pipes of the lower pumps.

As shown in Fig. 9, in the plant as first constructed, the discharge pipe of the lower pump on each shaft is the suction pipe of the upper pump on the same shaft, or the pumps are "compounded," as this arrangement is termed.

Water raised by the pumps is forced through a 12-in. cast-iron pipe to the measuring vault, shown in Figs. 7 and 8. Here it flows into a weir box formed by the bottom and sides of the vault, and thence, after passing over a 3-ft. weir, with end contractions, it continues, by gravity, through the tile pipe to the old well.

The Pelton motors are 24 ins. in diameter, and are set in specially-designed cases, each equipped with four independent gates and nozzles. The water used to run the motors is, after doing its work, discharged by gravity into the upper weir box in the measuring vault, out of which it flows, over a 3-ft. weir, to join the water raised by the pumps on its journey through the tile pipe to the old well. A hook gage is set at each of the weirs and measures the motor water and the water pumped.

In addition to the plant just described, three 6-in. driven wells were sunk between the cast-iron and the tile pipe lines, at distances of 1,050, 1,800 and 2,500 ft., respectively, from the old well. A brick masonry vault was built around each of these wells, the neck of the vault being carried up above high water mark, and protected against ice by a rubble stone masonry tower. In each vault was set an 18-in. Pelton motor coupled directly to a small centrifugal pump, Figs. 2 and 3, the pump drawing from the 6-in. well, and both motor and pump-water being discharged on to the floor of the vault. This floor is divided longitudinally by a vertical partition into two compartments, each of which serves as a weir box, and is equipped with a weir 1 ft. wide with end contractions. The motor water flows over one weir and the pump water over the other, and by means of a three-way cock, the depth of water over either weir can be measured by the hook gage set in the vault.

The plant at the new open well was finally started in October, 1895, and ran without interruption, day, night and Sunday, until January 1, 1896, when, the water supply having been replenished by rains, it was shut down. The only care required during that time, was the occasional lubrication of the bearings of the vertical shaft. During 1896, and for the first nine months of 1897, the plant was not required, and for months of that period, it was entirely submerged by the water in the well—being almost entirely under water for the whole of the time.

In October, 1897, the supplemental supply being again needed, after it had stood idle 21 months, the vertical shaft was turned a fraction of a revolution with a Stillson wrench, one of the nozzle gates of the Pelton wheel was opened, and the machinery started off, working as smoothly as though it had been shut down but a few minutes before. As the water in the well was lowered by the pumps, the shaft was lubricated, and the whole plant was found to be in good working order. It has been running almost continuously since, such shut downs as have occurred being due only to outside circumstances, in no way connected with the working of the plant itself.

Within the last few months, several changes and improvements have been made in the machinery, which have resulted in a decided gain in efficiency, as follows: When the plant was first put in, the imminent danger of a water famine left no time for the construction, or even for the selection, of the most suitable class and type of pumps. As a result, the pumps used were bought out of stock, with no further indication as to their proper speed and actual capacity than could be gained from the by no means accurate tables in the manufacturers' catalogue. Experience has proven that the efficiency of the pumps then bought was not as high as stated; and that their best speed was not, under the actual lift, the best speed of the 24-in. Pelton wheels under the actual pressure of the force main. For example each pair of pumps, compounded, with the actual lift of 28 ft., or 14 ft. to a pump, was found to lower the water in the well nearly to its minimum level, at a speed of about 480 revolutions per minute. The best speed for the 24-in. Pelton wheel under 120 lbs. pressure is between 610 and 640 revolutions. Consequently, the efficiency of the Pelton wheel was, at the working speed of the pumps, very much less than its maximum, and the combined efficiency of the plant proportionately smaller.

For these reasons, it was decided to try the experiment of removing the upper pump. Accordingly, the upper pump on the north shaft was taken out of the well, and the shaft was at the same time made continuous, and guided and supported by improved bearings. The revolutions increased at once from 480 to between 600 and 610 per minute; and the single pump at the higher speed delivered the same amount of water that the two had previously delivered, but with an expenditure of 30% less motor water. This gain in efficiency is due to the increased efficiency of the motor at the new speed; to the reduction in friction resulting from the use of improved bearings both for guides and supports; to the smaller number of bearings on the shaft; and to the saving in hydraulic friction by not having to force the water through the tortuous pasages of a second pump. Very little oil being required for the improved bearings, and there being no way in which the machinery can do itself any harm, the plant may be locked up and left to run alone for considerable periods of time. This is now actually done, and with the exception of an occasional perfunctory inspection of the plant and refilling of the lubricators by one of the regular pumping station force no labor is required to run it. The machinery needs but little more care than is usually bestowed on the familiar and reliable country house hydraulic ram.

While the plant as installed in Peoria consists, as stated, of Pelton wheel driving centrifugal pumps, the system is susceptible of broad variation, and any sort of water motor and any type of pump may be employed. It is the writer's intention in some future applications of the system, especially in such as may involve greater lifts, to put in tubular wells, with deep well pumps driven by Pelton or other similar water wheels.

As a general rule, the total capacity of an un-

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*For a fuller description of this steam plant, with an account of a duty test under ordinary working conditions, see paper by the writer. Trans. Ill Soc. Engrs. and Surv., 1897.

*For description of these tests, see paper by the writer, Trans. Ill., Soc. Engrs. and Surv., 1896. Eng. News, May 21, 1896.

derground water supply can be rendered available more cheaply by a large number of driven wells than by a smaller number of open wells, and the difficulty of sinking the latter becomes very much greater with the increase in depth. On the other hand, the first cost of centrifugal pumps of any given capacity is much less than that of deep well pumps of the same capacity. In choosing the type of well and pump to be employed, the engineer must, in each case, be governed by the local conditions.

With Pelton wheels, or others equally as good, on the same shaft with vertical centrifugal pumps, of modern design, under lifts of not over 35 ft., and with improved shaft and motor bearings, experience in Peoria shows that the following efficiencies may be realized:

	Per cent.
Pelton wheel	85
Centrifugal pump	65
Combined efficiency	55.25
Less for shaft friction and friction in force main and suction and discharge pipes	5.25
Net combined efficiency	50

For water motors geared directly to improved double-acting deep well pumps, the efficiencies may be estimated as follows:

	Per cent.
Pelton wheel	85
Improved deep-well pump	75
Combined efficiency	63.75
Less for friction in gearing for friction in force main and suction and discharge pipes	7.75
Net combined efficiency	56

With a duty at the main pumping station of 100,000,000 ft.-lbs. per 1,000 lbs. steam, these efficiencies would be for the plants using centrifugal and deep well pumps, respectively, 50,000,000 and 56,000,000 ft.-lbs. per 1,000 lbs. of steam—which for small isolated plants of from 500,000 to 1,000,000 gallons capacity, are much higher than could be obtained by any ordinary commercial steam plant.

With main pumping engines of still more modern make, and of, say, 140,000,000 ft.-lbs. duty, the net combined duty of the supplemental units would be from 70,000,000 ft. lbs. to 78,400,000 ft. lbs. per 1,000 lbs. of steam—which would probably exceed the duties obtainable in any other way from plants of so small capacity.

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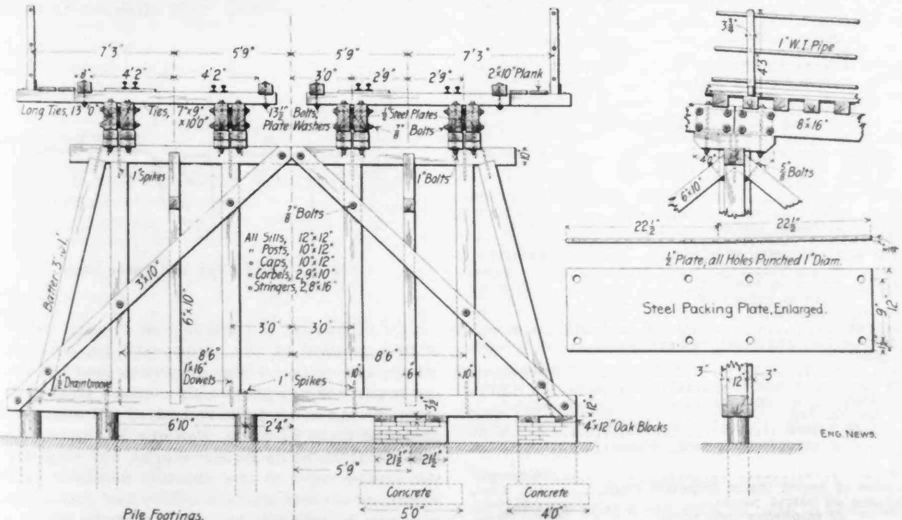
AN ELECTRIC RAILWAY TRESTLE AT LONG BRANCH, N. J.

The illustration herewith shows a section of a trestle built by J. G. White & Co., New York city, for the Atlantic Highlands, Red Bank & Long Branch Electric R. R. to obviate a grade crossing near Long Branch, N. J., where its right of way intersected the New York & Long Branch Ry.



DETAILS OF BENT USED IN TRESTLE AT LONG BRANCH, N. J., FOR THE ATLANTIC HIGHLANDS, RED BANK & LONG BRANCH ELECTRIC RY.

J. G. White & Co., Contractors.

As the tracks are practically parallel up to the point of crossing it was necessary to build one approach on a curve. The tracks proper are spanned by plate girders 69 ft. 2 ins. long. The difference of level between the rails of the steam and electric roads is 24.17 ft. The approach to the span on one side is a straight trestle about 210 ft. long with a 2.5% gradient, with the bents all resting upon brick and concrete foundations. On the other side the approach is a similar trestle with each bent resting upon six 12-in. piles. This section has a 5.8% grade and is built on a 6° curve.

The absence of mortises and the use of square ends for posts, with iron dowel pins is a noticeable feature. These ends and the steps cut for them were well daubed with asphaltum to prevent the collection of moisture and the consequent rotting of the timbers. In that portion of the figure showing the stringers in section, the absence of the usual heavy packing block is noticeable. Ordinarily where a trestle curves, these blocks must be cut to fit, a process involving more or less labor. As a substitute for this cumbersome device, and as a means of avoiding the corners and many chances for the collection of moisture, ½-in. iron packing blocks or plates, 23 × 12 ins., were employed. These were cut, drilled and bent in the shop and shipped ready to put in place. In erecting the trestle these plates were placed between the stringers with cast-iron washers on either side to hold the stringers away and allow air to circulate between the plate and stringers, as can be clearly seen in the elevation. Four bolts extending through from side to side of the stringers were used to draw the joint up tight. These splices were made every other bent; that is, the stringers are twice the length of one span. At the intervening points "spacers" composed of 12 × 12 × ½-in. iron plate were placed, using washers as with the metal packing plates already described.

The dimensions of the various timbers used are given in connection with dimensions of the same parts selected from Pennsylvania R. R. standards to show how nearly steam and present electric railway practice resemble each other.

Part.	Penn. R.R.	Long Branch trestle.
Sill, ins.	12 × 12, 10 × 12	12 × 12
Plumb posts, ins.	12 × 12, 10 × 12	10 × 12
Batter posts, ins.	10 × 12, 10 × 10	10 × 12
Caps, ins.	12 × 14, 10 × 12	10 × 12
Stringers, ins.	3 — 8 × 17 2 — 10 × 17	2 — 8 × 16
Corbels, ins.	10 × 10, 8 × 16	2 — 9 × 10
Sway braces, ins.	3 × 10	3 × 10
Longitudinal braces, ins.	8 × 8	6 × 10
Ties, ins.	7 × 10 × 9 ft.	7 × 9 × 10 ft.
Guard rails, ins.	5 × 8	6 × 8

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THE LIVERPOOL DOCKS.

In the January Consular Reports, Mr. James Boyle, U. S. Consul at Liverpool, speaks of the improvements in the Liverpool dock systems now in progress and proposed. The estimated cost of the completed work is about $21,500,000, and the work actually under construction includes the building of a new dry dock, 940 ft. long and 94 ft. wide, to cost $5,500,000. The new scheme proposes the enlargement of another dry dock, from 475 ft. to 1,000 ft. in length and 90 ft. wide, and the construction of two additional dry docks, one 630 ft. long by 80 ft. wide and the other 620 ft. and 80 ft. wide, to supplant two smaller existing docks. A number of the wet docks are also to be enlarged so as to take vessels 800 ft. long, and several will be fitted for ships 900 ft. long and one for a vessel 980 ft. long. The entrances to these larger docks will be 100 ft. wide.

The Mersey Docks and Harbor Board, by an act of Parliament of 1857, was given the control and management of all the docks at Liverpool, including those at Birkenhead, across the Mersey River. This board is made up of 28 members, 24 of whom are elected by shipowners, or "dock ratepayers," and the other four are appointed. They receive no compensation, though they manage the business of 90 docks in all, 67 being wet docks and 23 dry docks. The material of construction used in these docks is almost wholly Scotch granite, taken from the quarries belonging to the dock board. The docks have a frontage of about 7 miles, and the total frontage of the board's property is 8¼ miles, exclusive of certain undeveloped lands. The area of the dock estate, exclusive of wet and dry dock space, is about 1,000 acres. The smallest wet dock is about 160 × 120 ft., and the largest, at Birkenhead, is 3,300 ft. long and 600 ft. wide. The warehouses, belonging to the dock board and to individuals and corporations, aggregate nearly 7 miles in frontage length, and this does not include the facing warehouses belonging to railway, canal and other corporations. It is estimated that the entire property controlled by the dock board cost $200,000,000; and since 1857 the board has expended, up to July 1, 1897, $107,139,997. The total general receipts for the year ending July 1, 1897, were $5,997,934; and of this the statute required $486,000 to be carried to the sinking fund.

The harbor of Liverpool is a wide and deep roadstead in the narrow part of the estuary of the Mersey; with a safe and convenient anchorage for any number of large vessels for 5 miles up from the mouth of the river. But this roadstead has been only approachable from the sea at all stages of tide since the dredging improvements commenced in 1890. The tide range is very considerable, running from 32 ft. for spring tides to 11½ ft. at low neap tides; and the docks are only accessible from the roadstead twice in 24 hours, or at high tide.

But 11 miles seaward of the docks and stretching across the main channel, there was previous to 1890, a great, sandy bar, with only 10 to 11 ft. of water upon it at low water of spring tides. Active operations in maintaining a channel through this bar by dredging were only commenced in 1890, and the great centrifugal suction dredge boat "Brancker" was set to work in July, 1893, after suction boats with hopper-boats had been used for some time. This new boat is 320 ft. long and 46 ft. 10 ins. beam, has a hopper capacity of 3,000 tons of sand; is propelled by twin screws and can steam at a rate of 10 knots per hour. The two pumps are driven by direct-acting compound engines, and the orifice of each suction tube is 36 ins., with a delivery pipe of 45 ins. diameter. These pumps can fill the hoppers with average sand in 45 minutes, with a minimum of 25 minutes. The "Brancker" is claimed to have a record of 39,000 tons of sand in 24 hours, and 183,000 tons in 5½ continuous days, dredged and delivered. In November, 1895, the "G. B. Crow," a duplicate of the "Brancker," was set to work. Between 1890 and 1896, 17,000,000 tons of sand have been removed from the bar and the channel increased from 11 to 24 and 25 ft. in depth. As it was found that much of the fine sand was carried overboard with the overflow of water from the hoppers, a steam-tender with a water jet is now employed to stir up the sea face of the bar, to cause the lighter parts to be carried out to sea by the ebb current.

At the present time steamships load and unload cargoes and emigrants in the wet docks, but come to a floating "landing stage" for first-cabin passengers. This stage supplants the tender of two years ago. This landing-stage is nearly 4,000 ft. long and is from 80 to 100 ft. wide. It is supported on iron pontoons and rises and falls with the tide; hinged bridges connect with the shore.

It should be added that the Liverpool docks are maintained as a public trust; for the general benefit of the district and especially of Liverpool. The dock charges are so rated as to maintain the harbor and the docks, pay interest on the indebtedness and leave a stipulated annual deposit in the sinking fund. Under present efficient management there is a gradual reduction in dock and storage rates. The new elevated railway system in Liverpool is closely identified with the dock system, but is under an entirely separate management.

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LOCOMOTIVES WITH DOUBLE VALVES AND PORTS LONDON AND SOUTHWESTERN RY.

Attempts have been made at various times to improve the steam distribution in locomotives, and in our issue of June 10 we made reference to some English locomotives having double ports, the slide valves being divided into two parts, for the purpose of shortening the steam and exhaust passages. This arrangement, which is discussed in our editorial columns, was designed by Mr. Dugald Drummond, M. Inst. C. E., and we have recently received from Mr. Drummond (who is now Locomotive Engineer of the London & Southwestern Ry.) a photograph of one of the latest freight engines of the L. & S. W. Ry., which has this arrangement of valves and ports, and also drawings showing the details of the construction. The engine is shown in Fig. 1.

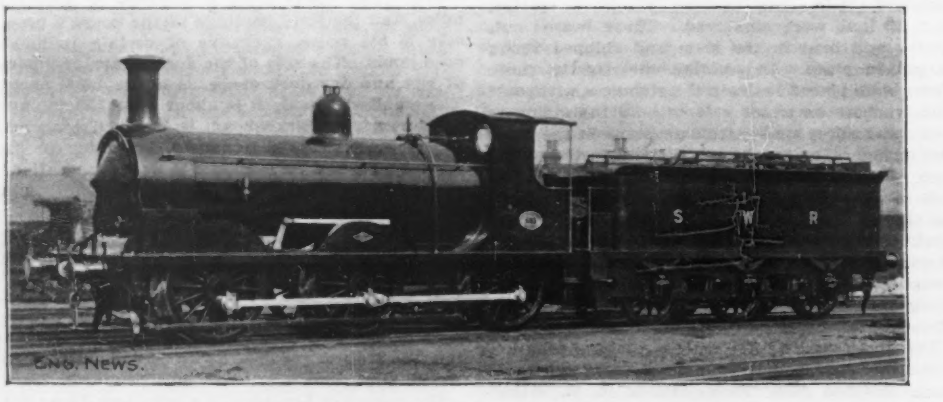

FIG. 1.—FREIGHT LOCOMOTIVE WITH DOUBLE SLIDE VALVES AND PORTS, LONDON & SOUTHWESTERN RY
Dugald Drummond, Locomotive Engineer; Dubs & Co., Builders.

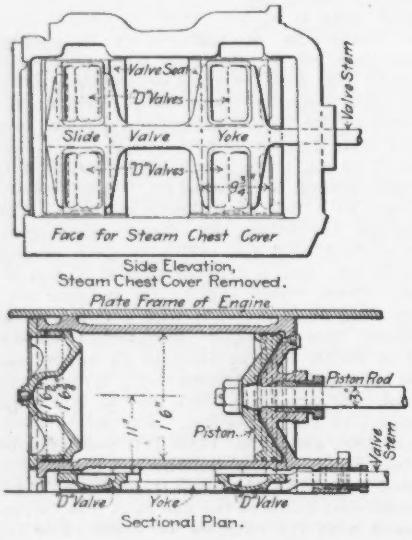

Fig. 2.—General Arrangement of Double Slide Valves and Ports.

Figs. 2, 3, 4 and 5 show the details of the valves and ports, not for the engine shown in Fig. 1, but for an eight-wheel passenger engine with cylinders 18 x 26 ins., and driving wheels 6 ft. 6 ins. diameter. Fig. 2 shows the general arrangement, the steam chests being between the inside cylinders, as is common in English practice, so that the valve seats are vertical. The four steam ports to each cylinder are 1⅝ x 8 ins., and the four exhaust ports are 3¼ x 8 ins., the bridges being 1¼ ins. wide. Fig. 3 shows the form of the valve yoke and stem, and Fig. 4 represents the complete slide valve, with the four D-valves secured in place in the yoke. Fig. 5 is a side elevation of the valve seat, from which it will be seen that there are practically no steam passages, the steam ports being directly at the ends of the cylinders.

The locomotive shown in Fig. 1 belongs to the ordinary type of English freight engines, having six wheels, all coupled, and 30 of these engines have been built for the road during the present year by Messrs. Dubs & Co., of Glasgow. The engine has inside cylinders and is severely plain in appearance. All the driving springs are below the axles, the main driving axle having helical springs, while the coupled axles have plate springs. There is a short smokebox, with peculiar conical door, and the sandbox is formed in the forward part of the splasher over the leading wheels. The dome is mounted at the back end of the barrel. The tender has heavy plate frames of the ordinary English pattern, and is carried on six wheels of much larger diameter than is usual in American practice. All the engine and tender wheels are fitted with brakes, and the engine has hose connections for the vacuum train brake.

The leading dimensions of these engines are as follows:

Freight Locomotive; London & Southwestern Ry.

Running Gear:	
Driving wheels, diameter	5 ft. 1 in.
Tender, wheels, diameter	4 ft.
Journals, driving axle	8 x 7¼ ins.
Journals, coupled axles	8 x 7½ "
Journals, tender axles	12 x 6 "
Wheel Base:	
Leading axle to driving axle	7 ft. 6 ins.
Driving axle to trailing axle	9 " 0 "
Total engine	16 " 6 "
" tender	13 " 0 "
" engine and tender	39 " 1 "
Weight in Working Order:	
On leading wheels	29,792 lbs.
On driving wheels	35,840 "
On trailing wheels	28,6[illegible] "
Engine, total	94,304 "
Tender, total	82,208 "
Engine and tender, loaded	176,512 "
Tender, empty	42,112 "
Of full water capacity of tank	35,000 "
Cylinders	18¼ x 26 ins.
Distance, center to center	2 ft. 3 ins.
" center to valve face	11⅜ "
Piston rod, diameter	3 "
Crosshead	Forged solid with piston rod.
Connecting rod, length between centers	6 ft. 6 ins.
Valve Gear:	
Type	Stephenson.
Ports (double), steam (4)	1⅝ x 8 ins.
Ports (double), exhaust (4)	3¼ x 8 "
Slide valves, lap	1 in.
" " lead	⅛-in.
" " maximum travel	4⅛ ins.
Boiler:	
Type	Telescopic.
Diameter of barrel inside (smallest ring)	4 ft. 4 ins.
Thickness of barrel plates	9-16-in.
" of smokebox tube plate	¾-in.
Height from rail to center line	7 ft. 3 ins.
Length of smokebox	2 " 6¾"
Working steam pressure	175 lbs.
Firebox:	
Length, inside ...top, 3 ft. 5⅝ ins.; bottom,	5 ft. 9⅝ ins.
Width, inside. .... " 3 " 7 " ; "	3 " 6⅛ "
Depth at front	6 " 2 "
Depth at back	5 " 8 "
Thickness of side plates	9-16-in.
" back plate	9-16-in.
" crown sheet	9-16-in.
" tube sheet	⅝ and 9-16-in.
Grate area	20.368 sq. ft.
Water space, width	2 ins.
Tubes.—Material, brass;	number, 216
Pitch	2[illegible] ins.
Diameter, outside	1[illegible] "
Length between tube plates	10 ft. [illegible] "
Heating surface:	
Tubes, exterior	1,067.785 sq. ft.
Firebox	123.900 "
Total with exterior tube area	1,191.685 "
Miscellaneous:	
Exhaust nozzle, diameter	5 1-16 ins.
Smokestack, smallest diameter	1 ft. 4 "
" height from rail to top	12 ft. 11[illegible] "
Capacity of tank......3,500 imp. galls.;	4,200 U. S. galls.
Capacity of coal space	160 cu. ft.
Brake fittings	Vacuum.

* * *

OPINIONS ON THE SAND-BLAST FOR CLEANING STRUCTURAL IRON.

The application of the sand-blast, in removing the old paint from the 155th St. Viaduct, in New York city, preparatory to repainting the iron surface, was fully described in our issue of Sept. 23, 1897. This viaduct was greatly exposed to the corroding action of hot gases from the locomotives of the Manhattan Elevated R. R. stopping immediately beneath it, and all previous efforts to keep paint upon the structure for any length of time had failed. Though the iron work had received four separate coats of paint in the four years that had elapsed since erection, this paint showed a decided tendency to scale off in an exceedingly short time, and as a consequence the iron was badly rusted and pitted.

The Department of Public Works took the matter in hand, and Mr. E. P. North, M. Am. Soc. C. E. and Consulting Engineer to the Department, concluded that the chief trouble lay in securing a thoroughly clean surface for the first coat of paint, and the insurance of perfect contact between the iron and the paint. As ordinary wire brush work would not satisfactorily clean the surface the Tilghman sand-blast process was carefully tested. The judiciousness of the application of the sand-blast to similar structures has been publicly questioned; and Mr. North has asked an expression of opinion on this head from a number of engineers competent to judge, and who examined the work in progress, and he has printed the replies received in pamphlet form.

The concensus of these replies, from about 20 prominent engineers, is that the use of the sand-blast for the purpose intended was both wise and judicious. None of these men know of a better method of removing scale, rust and paint from all parts of an iron structure; and the most of them add that the wire-brush will not satisfactorily perform this work. Mr. J. E. Greiner, Engineer of Bridges on the Baltimore & Ohio R. R., believes that the cleaning on this viaduct is so effective that the utimate success of the work will depend solely upon the qualitiy of paint used. Mr. Horace Andrews, City Engineer of Albany, N. Y., in approving of the method, calls attention to the difficulty of having the metal well cleaned before it is first painted at the shops; and he, with many others, is convinced that all money spent in painting a surface not previously cleaned from rust, is wasted. As a competitive test of different paints, obtained from 17 firms, was one of the objects of the Department of Public Works, the majority of the replies refer to the absolute necessity of first obtaining a clean surface before any just comparison can be made of the quality of the paints applied.

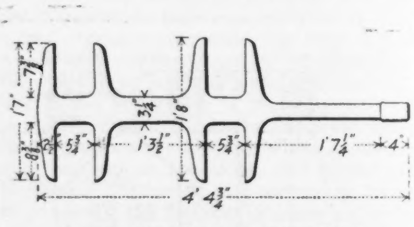

Fig. 3.—Valve Yoke and Valve Stem.

The sand-blast method of cleaning is admitted to be costly; but where thorough cleaning is demanded it seems to be the only process that is at all satisfactory. The statement has been made, says Mr. W. N. Riegner, Engineer of Bridges on the Philadelphia & Reading R. R., that metal so treated will rust more rapidly when the hot gases once penetrate the paint, than if it had not been sand-blasted. Mr. Riegner is testing this claim with special reference to train-shed roofs. Two rusted sheets of iron have been taken and the one-half of each cleaned with the sand-blast; each sheet was then painted all over, one with graphite paint and the other with oxide of iron, and the two sheets will be exposed one year. No report has yet been made upon them.

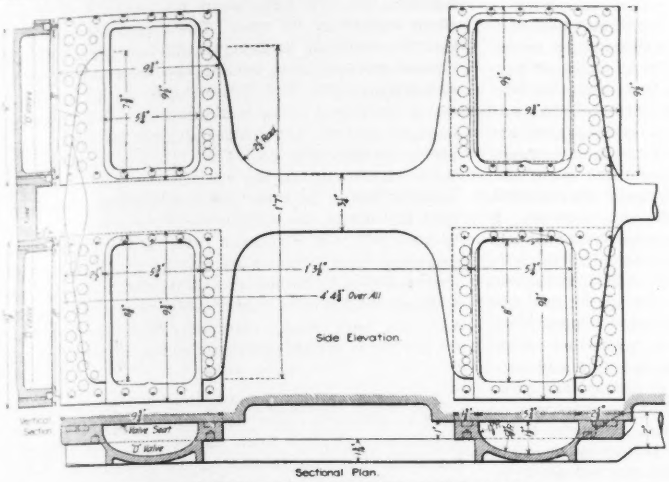

FIG. 4.—DETAILS OF COMPLETED SLIDE VALVE.

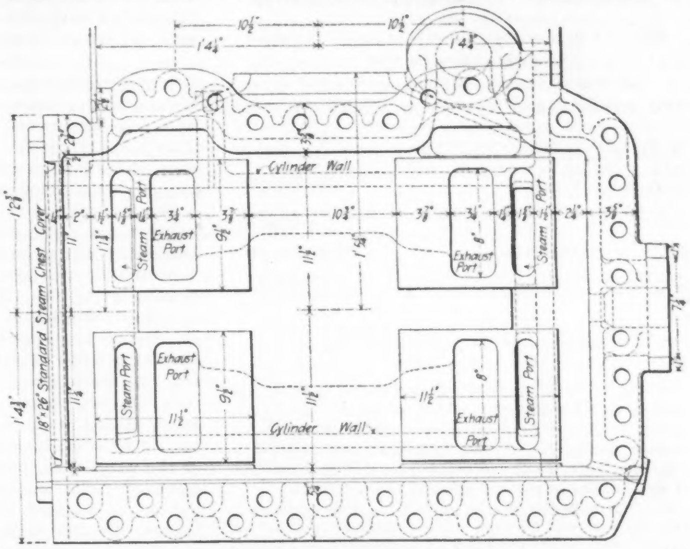

FIG. 5.—SIDE ELEVATION OF VALVE SEAT.

Mr. Layton F. Smith, Assistant Engineer in Charge of Bridges of the City of Baltimore, describes a city bridge over the Pennsylvania R. R., at Argyle Ave., which is situated between the portals of two tunnels and much exposed to escaping gas and steam. This bridge had not been painted since erection, 20 years ago, and was in a very bad condition. The scale was over ¼-in. thick and the iron and steel pitted to a depth of 1-32 to 1-16-in. Chipping hammers, steel scrapers and steel brushes were used to clean this bridge, at a cost of about 5 cts. per sq. ft., but the result was not satisfactory. Mr. Smith visited the work in progress at 155th St., and was so convinced of the superiority of the sand-blast method of cleaning structures that he has advocated the purchase of a plant for the City of Baltimore. Mr. Charles M. Mills, of the Department of Public Works of Philadelphia, says that owing to the irregularity of the bridge members and frequent inaccessible surfaces caused by structural connections, it is practically impossible to thoroughly remove all rust by scrapers and steel brushes, without an expenditure of time and labor that would be considered prohibitory. He added that the cleaning by the sand blast was complete; and to approach the same degree of cleaning with the scraper, brush and chisel would now cost more than the sand-blast.

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THE VENTILATION OF THE SUB-SOIL ABOUT houses is advocated by H. Koschmider, in the "Gesundheits Ingeniur." After referring to improved health conditions resulting from the gradual purification of the subsoil by modern sewerage works, he describes a plan of his own for preventing the entry of vitiated air from the sub-soil into a cellar. This is practically a hollow foundation wall; or, a wall built inside so as to leave a dry area around the basement. This space takes up the bad air coming from the soil outside, and the air is exhausted from it by a vertical pipe carried up in the center of the house, with branches leading into the front and back dry areas. He claims that by its situation the air in the vertical pipe will be heated and an up draft will be formed which will carry away the foul air and prevent it from entering the house. For the soil of European cities, saturated by the accumulated filth of centuries, such an expense might be warranted.

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THE VALUE OF THE EXPERT.*

Ony one who has attained to the capacity for exact observation and exact description, and knows what it is to draw a correct inference from well-determined premises, will naturally acquire a respect for these powers when exhibited by others in fields unknown to him. Moreover, any one who has learned how hard it is to determine a fact, to state it accurately, and to draw from it the justly limited inference, will be sure that he himself cannot do these things except in a very limited field. He will know that his own personal activity must be limited to a few subjects if his capacity is to be really excellent in any. He will be sure that the too common belief that a Yankee can turn his hand to anything is a mischievous delusion. Having, as the result of his education, some vision of the great range of knowledge and capacity needed in the business of the world, he will respect the trained capacities which he sees developed in great diversity in other people; in short, he will come to respect and confide in the expert in every field of human activity. Confidence in experts, and willingness to employ them and abide by their decision, are among the best signs of intelligence in an educated individual or an educated community; and in any democracy which is to thrive, this respect and confidence must be felt strongly by the majority of the population. In the conduct of private and corporation business in the United States, the employment of experts is well recognized as the only rational and successful method. No one would think of building a bridge or a dam, or setting up a power station or a cotton-mill, without relying absolutely upon the advice of intelligent experts. The democracy must learn, in governmental affairs, whether municipal, State or National, to employ experts and abide by their decisions. Such complicated subjects as taxation, finance and public works cannot be wisely managed by popular assemblies or their committees, or by executive officers who have no special acquaintance with these most difficult subjects. American experience during the last twenty years demonstrates that popular assemblies have become absolutely incapable of dealing wisely with any of these great subjects. A Legislature or a Congress can indicate by legislation the object it wishes to attain; but to devise the means of attaining that object in taxation, currency, finance, or public works, and to expend the money appropriated by the constituted authorities for the object, must be functions of experts. Legislators and executives are changed so frequently under the American system of local representation that few gain anything that deserves to be called experience in legislation or administration; while the few who serve long terms are apt to be so absorbed in the routine work of carrying on the government and managing the party interests that they have no time either for thorough research or for invention. Under present conditions neither expert knowledge nor intellectual leadership can reasonably be expected of them. Democracies will not be safe until the population has learned that governmental affairs must be conducted on the same principles on which successful private and corporate business is conducted; and therefore it should be one of the principal objects of democratic education so to train the minds of the children that when they become adult they shall have within their own experience the grounds of respect for the attainments of experts in every branch of governmental, industrial and social activity, and of confidence in their advice.

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A STANDARD SCALE OF PRICES FOR STRUCTURAL STEEL.*

At a meeting of manufacturers of structural material held in New York city on Tuesday, Dec. 28, a schedule of delivered prices was agreed upon for beams and channels, tees, zees and angles. These delivered prices are based on 1.15 ct. f. o. b. cars Pittsburg for beams and channels from 3 ins. to 15 ins., 1.25 ct. for 18-in., 20-in. and 24-in. beams, 1.20 ct. for tees, 1.15 ct. for zees, 1.10 ct. for universal mill plates and 1 ct. for angles, bars and sheared plates ¼-in. and heavier. These prices went into effect on Dec. 28, 1897, and are on the basis of 30 days. No discount is allowed for cash, except legal interest—6%. We give below the delivered prices as adopted by the manufacturers, as follows:

Points of delivery.	nels, 3 ins. to 15 ins. Cts.	Tees, 3 ins. and larger. Cts.	Zees, 3 ins. and larger. Cts.	Angles, 3 ins. and larger. Cts.
New England States, points taking Boston or Portland rate, or equivalent	1.32½	1.37½	1.32½	1.17½
New York (east of Rochester and Rochester), Pennsylvania (east of Altoona), Maryland, District of Columbia, New Jersey and Delaware	1.30	1.35	1.30	1.15
New York (west of Rochester), Pennsylvania (west of Altoona and Altoona), except Pittsburg and points immediately adjacent, Ohio and West Virginia (except to nearby points where freight is less than 10 cts. and rate shall be Pittsburg price, plus actual freight)	1.25	1.30	1.25	1.10
Pittsburg and Allegheny (for use there)	1.15	1.20	1.15	1.00
To points immediately adjacent add actual freight rate to obtain delivered price.				
Indiana, Michigan, Kentucky, cities of Chicago and Milwaukee	1.30	1.30	1.30	1.15
Illinois (except Chicago), Virginia and Wisconsin (except Milwaukee)	1.35	1.40	1.35	1.20
All points on the Mississippi River, excepting towns in Missouri, Illinois and Iowa	1.40	1.45	1.40	1.25
River towns in Missouri, Illinois and Iowa	1.35	1.40	1.35	1.20
North Carolina, South Carolina, Georgia, Florida, Tennessee, Alabama, Iowa, Missouri (except Mississippi River points), Minnesota (except Mississippi River and lake points) and Kansas	1.50	1.55	1.50	1.35
Lake points in Minnesota	1.40	1.45	1.40	1.25
Louisiana and Mississippi (except Mississippi River towns), Arkansas and Nebraska	1.60	1.65	1.60	1.45
Texas (common points)	1.75	1.80	1.75	1.60
Colorado, Texas (outside of common points) and Wyoming	2.05	2.10	2.05	1.90
All other States and Territories not covered above (except Pacific Coast States)	2.55	2.60	2.55	2.40

Pacific coast not to be covered.

18-in., 20-in. and 24-in. beams, 10 cts. per 100 lbs. more.

The following extras are to be added to base price (per pound) of beams and channels:

	Cts.
For cutting to length with less variation than ⅜-in.	1-10
For plain punching one size hole in web only	1-10
For plain punching one size hole in flanges only	1-10
For plain punching one size hole, both web and flange	2-10
For plain punching each additional size hole	1-10
For assembling into girders, including bolts, separators and punching	3-10
For coping, beveling, fitting ends, including cutting to exact length, with or without punching; also including the riveting or bolting of connection plates or connection angles	3-10
For painting or oiling one coat with ordinary paint or oil	5-100
For bending or other unusual work	shop rates.
For chambering beams and channels for ships or other purposes	1-10
For fittings, whether loose or attached, such as angle connections, bolts, separators, tie-rods, etc.	1½

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*From an address by President Chas. W. Eliot, of Harvard University, on "The Function of Education in Democratic Society," delivered at the dedication of the new Museum Building of the Brooklyn Institute of Arts and Sciences and printed in "The Outlook."

*From "The Iron Age" of Jan. 6.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

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

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

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

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

Mailing addresses may be changed at will by sending both old and new address. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 326 means that subscription is paid to the 32d week (that is the issue of Aug. 12) of the year 1897; the change of these figures is the only receipt sent, unless by special request.

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

A problem which has attracted the attention of many locomotive designers has been that of improving the steam distribution, and this problem increases in importance in proportion to the speed of the engines, being specially important for express engines, with high piston speeds. It would seem, however, as though the problem proved difficult of solution, or that most of the solutions thus far made have been found to effect but little practical improvement over the ordinary system, since the old and ordinary system of using a single slide valve and three ports (two for steam and one for exhaust) continues to be almost universally used. The use of piston valves effects some improvement in this respect, but such valves are little used in this country except in compound locomotives. The Midland Ry., of England, however, has had very satisfactory results with such valves on a number of simple engines. In a paper on "Piston Valves in Locomotives," read at the Engineering Conference of the Institution of Civil Engineers, in June, Mr. Samuel W. Johnson, Locomotive Superintendent of the Midland Ry., stated that by the use of such valves the steam passages can be made shorter and more direct, while the clearance spaces can be reduced. At the same time long steam ports can be put in, giving a good steam admission and a quick and free escape for the exhaust steam. They allow trapped water to escape more readily and they show much less wear than the ordinary slide valve. In six months eight engines with piston valves showed an average coal consumption of 29 lbs. per mile, while 13 engines with slide valves, running in similar service, but with slightly lighter average train loads, showed a consumption of 30.04 lbs. per mile. Piston valves were briefly referred to at the convention of the Railway Master Mechanics' Association in June, but Mr. Rhodes (of the Chicago, Burlington & Quincy R. R.), who has two simple engines equipped with these valves, referred in his remarks mainly to the greater ease of handling piston valves than slide valves on engines carrying high steam pressures. On the European Continent this same problem has been tackled, but as foreign engineers are largely addicted to the use of complicated devices, the mechanical solution of the problem is usually a distressing collection of valves, operating rods, cranks, etc., the practical results of which would seem more likely to interfere with than to improve the steam distribution. This side of the case has been presented in our issues of Oct. 26, 1893, and May 28, 1896, in connection with the application of the Bonnefond and Corliss valve gears to French locomotives.

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While English engineers are very generally conservative, yet when they do make changes or devise new plans they are usually on lines of simplicity, which may account in part for the success of the piston valves on the Midland Ry., and we show in another column a simple and apparently effective means of improving the steam distribution of locomotives which has been devised and put in use by Mr. Dugald Drummond, Locomotive Superintendent of the London & Southwestern Ry. This arrangement was briefly noted in our issue of June 10, in an editorial note on Mr. Drummond's paper on "High Pressures in Compound Locomotives." In place of one set of three ports, Mr. Drummond uses four sets of two ports each, two pairs of ports being placed at each end of the cylinder and separated by a bridge over which is carried the yoke of the valve. This yoke is a rod or bar having two pairs of forks on each side, and between these yokes are secured four plain D-valves or slide valves. By this arrangement all the valves form practically one large valve, which is operated in the usual way, with no additional gear, while both steam and exhaust passages are made shorter and more direct than in the ordinary arrangement. On comparing the dimensions of two eight-wheel passenger engines, of approximately the same class, of the London & Southwestern Ry. and the New York Central R. R., we find that the former has two steam ports 1⅝ × 8 ins. (26 sq. ins.), opening directly into each end of the cylinder, instead of one port 1¼ × 18 ins. (22½ sq. ins.) with a long steam passage, and the four exhaust ports, 3¼ × 8 ins., of the former, have an area of 104 sq. ins., as compared with 49½ ins., for the ordinary single port of 2¾ × 18 ins. on the latter engine. The arrangement is so simple and promises such good results that it is well worth the careful attention of locomotive designers in this country.

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Several new processes of sewage purification have been announced in England within the past few years. The process which just now is attracting most attention is the septic tank system, described elsewhere in this issue. It seems to have more that is really new, and perhaps promising, than any of the other recent schemes. All plans now attracting so much attention depend upon bacterial action. In general, their design is to aid the bacteria in carrying on the work they are so ready to do by giving them the most favorable environment possible, thus increasing their numbers and their appetites, and, consequently, the amount of organic matter which they reduce, to the greatest possible extent. Some of the schemes have seemed to differ little, if any, from intermittent filtration, as practiced and studied experimentally with so good results for the past ten years in this country. In others there has been a more decided attempt to increase the amount of oxygen available for the bacterial and oxydizing processes.

The septic tank system differs from the other new English processes in that it attempts to bring an entirely new and different class of bacteria into operation, the anaerobic. These bacteria thrive in the absence of oxygen, and are the organisms that give rise to putrefaction. The bacteria whose aid is sought in the other processes, including the land treatment of sewage, are aerobic. That is, oxygen, and plenty of it, is essential to their life processes. They effect, under proper conditions, the decomposition of organic matter and its change to stable forms without any offensive odors.

The theory of the septic tank is that it, by means of the putrefactive bacteria, breaks down the suspended organic matter of the sewage, sedimentation carrying most of the suspended inorganic matter to the bottom of the tank. Of the broken down, suspended organic matter, some passes to the filter beds in solution, some in a finely-suspended state, and some is supposed to escape as carbonic acid and marsh gas and as free nitrogen.

Several eminent English authorities, like W. J. Dibdin, late Chemist to the London County Council, and Dr. G. Sims Woodhead, the bacteriologist, seem to think that the process effects wonderful results, but we have seen no expressions from them regarding its cost. The enormous tank capacity required, to furnish storage for about 24 hours' sewage flow, makes the expenses of construction heavy; but if the tanks can be operated for a year, removing some 80% of the suspended organic matter, and practically all the other matter in suspension, and that with no expense for labor or chemicals, the system is certainly worth looking into. It must be remembered, however, that the tanks are supplemented by filters, though these work at a very high rate. If the Local Government Board insists on having the filtrate further purified by broad irrigation, the treatment, as a whole, will not be remarkably simple, and probably not very cheap, especially where some or all of the three stages make pumping necessary.

◆

A very sensible proposition concerning New York's dilemma over its expenditure on canal improvements has been made by Hon. Jas. A. Roberts, the Comptroller of the State, who is by virtue of his office a member of the Canal Board. It is in substance that the State officers should at once suspend work on such of the canal contracts as are not already substantially completed, or at least on those for which contracts were let during the past summer, but which are still practcially untouched. It is conceded on all hands that little practical benefit will be obtained from the improvement until the deepening is completed for the whole length of the canal; and as the question as to the appropriation of funds to complete this work must be submitted to a popular vote, the State would save about $3,000,000 in case the vote should be adverse. Mr. Roberts' argument for this course is so admirably clear that we reprint part of it as follows:

> It would appear to me that we have no right to assume that the people would have authorized the expenditure of $16,000,000 for this improvement simply because they authorized the expenditure of $9,000,000; or that they would have authorized the expenditure of the $9,000,000 had they realized that that sum would only half do the work. It follows, then, that they should now have an opportunity to express their wish upon the situation as it now appears before any further money is expended. That certainly would be the course taken in a private matter. If one individual undertakes to work for another, with a clear understanding that it can be done for a specified sum, it would clearly be the duty of the contractor to notify his employer as soon as he discovered that the cost would exceed the estimate, to stop expenditures at once and take his employer's directions. If that be honesty between individuals, why is it not between public servants and the people?

The Controller's suggestion is receiving wide approval by the press of the State; and although some opposition is heard, the fact that he controls the purse-strings makes it possible that at least those contracts not yet under way may be cancelled by the State. Of course, contractors would be entitled to some recompense in such a case; but the State could better afford to pay it, than to expend the entire amount for work that may be of no benefit whatever, if the funds to complete the deepening of the canal are not forthcoming. There is, in fact, a general demand by the State press that a halt shall be called, and the whole matter of canal improvement shall be carefully investigated before a decision is made as to the best course for the State to pursue.

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In the arguments presented by those who oppose anything but the completion of the entire work as planned, no matter what its cost, one statement that frequently appears is that the canals are worth the million and a half, more or less, which the State annually expends on their account merely by reason of their influence in keeping down railway freight rates; and that the State could well afford to keep them up even if actual traffic on them were to practically disappear.

Very likely this was true twenty years ago; but it does not follow that it is true to-day; and we know of no one who has made any real investigation to see whether it is true to-day. Furthermore, even if it is the fact at the present time that the canal exerts a considerable influence in lowering railway rates, it does not follow that it will do so five years hence.

The fact is, that the canal is only one competing factor in the business of transportation between the lakes and the seaboard. There are four independent and competing railway lines between Buffalo and New York, all of them hustling for business. Last year, of all the grain going east from Buffalo the railways carried eleven bushels to every one that the canal carried. However much these railways might like to raise their rates, they cannot do so to any considerable extent without diverting traffic to other routes. The Erie, the Lackawanna, the Lehigh Valley and the Vanderbilt lines are not going to put up the freight rates if to do so means the diversion of large amounts to the rail lines which run to the seaboard from Chicago, Cleveland, Erie and other lake ports, or to the Canadian water route 14 ft. deep, from Lake Superior to the sea, or to the railway lines that reach the Gulf ports of New Orleans and Galveston.

These new avenues for traffic did not exist when the late Albert Fink gave his much-quoted opinion respecting the influence of the Erie Canal on railway rates. They must be taken into account in considering what the value of the canal may be as a rate regulator at the present time and what it is likely to be in the future.

In our last issue it was stated that Mr. J. F. Wallace, M. Am. Soc. C. E., late Chief Engineer of the Illinois Central R. R. Co., had been appointed Assistant to the Second Vice-President of that company. Mr. Wallace was actually made Assistant Second Vice-President, a position of quite a different sort, as most of our readers will recognize.

AN OPPORTUNITY FOR THE AMERICAN SOCIETY OF CIVIL ENGINEERS.

The American Society of Civil Engineers will hold its annual meeting next week in its beautiful and spacious new house, in New York city, which was opened with appropriate ceremonies six weeks ago. The Society ranks easily as the largest, the most influential, the most representative, and, last, but not least, the wealthiest of the engineering societies of this country. It has an annual income in the neighborhood of $30,000, and it is housed in a spacious building that has cost, with the land that it occupies, not far from $200,000.

Now one of the chief duties of the engineer as a manager of enterprises is to see that the capital invested and the sums expended for operation and maintenance are made to yield the largest possible return in production. It may well be expected, then, that a socety of engineers will put its machinery to the best possible use; and the question arises, then, how can this society be of the greatest possible use to its members and to the profession at large. Can the very considerable investment that its members are making in the Society be made to yield them a larger return in the future than it has done in the past?

We shall not attempt here to set forth every direction in which the Society is or can be of use. That were too large a task for our present space. What we desire is to call attention to one particular field in which, it seems to us, this Society has an opportunity that is presented to no other engineering society in this country, and one which it is especially desirable that the Society should cultivate, since it furnishes an answer to the vexed question: What can the Society do to make a more adequate return to its non-resident members?

The proposal we have to make is, briefly stated, that a very considerable extension should be made to the scope and usefulness of the Society's library. In its new house the Society has such an abundance of shelf-room that the books and pamphlets of its present library, about 20,000 in number, fill hardly a quarter of the space. In the old house, lack of space made proper classification and arrangement for convenient reference, a most difficult task. In the new house every mechanical aid has been provided to facilitate this work, and the abundance of space and light are in pleasing contrast to the old quarters.

With these admirable facilities, with the extensive collection it already posseses, and with the funds at its disposal to maintain a sufficient working staff to classify and index this mass of engineering literature, and to keep it at all times up to date by the addition of every engineering book, pamphlet, periodical or report that contains anything worth preserving for future reference, we see no reason why the library of the American Society of Civil Engineers should not be made the most useful engineering library in the world.

It may be said that some of the public libraries with much larger funds at their disposal, should be able to do better work for the profession than the library of an engineering society; but even more important than ample funds is the knowledge of what engineers need, and the ability to select and classify understandingly the literature of the profession. Doubtless many of our readers can testify from experience to the "rubbishy" character of much of the so-called engineering literature, which is to be found in even the best public libraries. Engineering treatises of the "popular" sort are what usually appeal to the head of a public library; and these, as a rule, are of little practical account to the working engineer. Further, there is really no reason to expect that purely technical treatises, or at least those of interest solely to engineers, should be included in a library supported by general taxation. It would be more reasonable to maintain a medical library, for the benefit of the physicians in a community, for they are far more numerous than the engineers.

We repeat, then, that the library in the Civil Engineers' new house ought to be the most useful engineering library in the world. Further, we see no reason why some system might not be developed whereby this library should be made available to engineers away from New York, through the furnishing of data and references on engineering subjects by the working staff of the library upon requests from members, or, if thought best, from non-members as well.

It is within the memory of men now in active service, and who do not call themselves old, either, that engineering literature was once so small in bulk that all that was of any considerable value could be contained in the private library of a working engineer.

Engineering then covered a narrow field. Today its field is so broad that no one man can pretend to more than a casual knowledge of all its branches. Moreover, the development of new industries, new methods of applying "the great powers of Nature," new applications of her varied stores of raw materials, are all the time creating new departments and new specialties in the profession.

The bulk of technical literature has become so great that the busy engineer finds it a hard task to keep himself up to date in the special field of his own labors, and when a question arises in some other branch of engineering, he is obliged to either consult the authorities, or run the risk of making a blunder. But how shall he consult the authorities? The average engineer's private library has to be in pretty compact form on account of his frequent changes in location, to say nothing of the limitations which his purse may set. Even the engineer in consulting practice, who can accumulate a fairly extensive library, very frequently finds himself in need of more data for the solution of some vexed question. Where should the engineer look for the largest possible collection of data and records of experience if not to the library of a great national engineering society?

A topic frequently discussed among engineers is the need of some comprehensive index to all existing engineering literature. The need is universally admitted, but the task involved in its preparation is so great that no individual and no publishing firm could undertake it merely as a commercial venture. A great engineering society, however, might properly undertake such a work, and, if well done on a broad scale, it should be of incalculable value to the entire profession.

We realize that the preparation of such an index would be a labor of years, and that it would require an engineer of the broadest attainments to plan and supervise it. But it is also evident that unless something of the kind is done by a powerful organization of engineers, it will never be done; and until it is accomplished, a large part of even the best engineering libraries is left in great part useless to the profession. Time is one of the most highly valued assets of the busy engineer; and time is not at his disposal to make the search for himself; so he is now forced to do without very valuable data; perhaps most pertinent material of exceeding usefulness to himself and to his clients. Not a day passes that letters do not come to us asking for information on some matter or other of engineering practice; and we fully believe that if once such a thorough and complete engineering index as we have outlined were made available, the fees that would willingly be paid for its use would be sufficient to provide for its maintenance.

The first task for the American Society of Civil Engineers, is manifestly to take advantage of its enlarged quarters and fill up its library with all the best and latest books that come properly within its field, and with the reports and professional papers of engineers and of engineering and technical societies that can easily be obtained for the asking, and which contain often information of great value. At the same time the cataloguing of all this material can go on, and at least a start could be made on such a broad and general index as we have outlined. In fact the card catalogue of the library itself would be a proper nucleus for such an index.

In conclusion, we would lay emphasis on our proposition that the library ought to be made available to the non-resident members as well as to those in New York, or better yet, with suitable provisions as to fees, to all practicing engineers. This, it seems to us, might be done at an early day, with the aid of such catalogues and indices as at present exist. Two-thirds of the members of the Society live so far from New York that they derive practically no benefit from the Society's house, and can attend few of the Society's meetings. A large proportion of these members are so located that the maintenance of a private reference library comprising more than a few standard pocket-books, is impossible; and no public library available to them contains works of any practical value. If the Society were to make available to such of its members, even in such measure as its present facilities render possible, the information in its library, it would confer upon them a benefit of more direct practical value, we believe, than all the Society now does for them.

LETTERS TO THE EDITOR.

A Misleading Circular.

Sir: A circular signed by the Goheen Manufacturing Co., of Canton, O., has been sent to me with photographs showing the corrosion of the viaduct at 155th St. Under the photograph is a legend saying in part, "it is now being cleaned by sand-blast and painted with two coats of carbonizing coating manufactured only by the Goheen Manufacturing Co., Canton, O."

As this may be misleading I will be obliged to you if you will say for me that the Goheen Manufacturing Co.'s paint has been applied to less than 1% of the whole viaduct and to only 1-17th of the area painted.

Respectfully, Edward C. North,
Consulting Engineer.
Dept. Pub. Works, 150 Nassau St., New York, Dec. 31, 1897.

Support of Double-Headed Rails.

Sir: With reference to an article headed "American Rails for India," and more especially the second paragraph of the same, as printed on page 190 of your issue of Sept. 16, 1897, I think it as well to remind you that the greater part of the main line of the East Indian Railway is laid with Denham-Olpherts' cast-iron sleepers, and therefore your concluding remarks, about the lower heads of double-headed rails becoming indented at the points where they rest in the chairs, do not apply, as with Denham-Olpherts' sleepers the rail is suspended and supported by the jaws, the lower head being quite clear of the sleepers, and not resting on them in any way.

Yours very faithfully, J. Scott,
Res. Engr. Sone Bridge,
Moghal Serai Gaya Extension, East Indian Ry.
Dehri, Bengal, Nov. 18, 1897.

(Our remarks as to the wear of the lower heads of double-headed rails referred to the ordinary construction of track with such rails, in which the lower heads of the rails rest on a seat formed in the cast-iron chair. In the construction with the Denham-Olpherts' cast-iron plate ties the upper head of the rail rests on jaws on the ties, the rail being thus suspended by its head. While this latter system of construction is extensively employed in India, yet the general system of construction with double-headed and bull-headed rails is to support them in the way first mentioned, thus involving the objection referred to.—Ed.)

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Hints on Road Construction.

Sir: What I intend saying may not be new to many of your readers, but as the building of macadamized roads is becoming quite a business, we who have some experience strike something once in a while which may be useful to others.

The quantity of rolling considered desirable is a serious question, and it is hard to specify a certain number of hours, with a certain weight roller, for a certain number of square feet of surface, for all kinds of rock. I have lately drawn up my specifications to read that the foundation (i. e., the earth surface after having been cut to the proper depth and the soft places filled with sand or fine broken stone) and each layer "shall be rolled with a roller of not less than five tons weight and sprinkled; and said sprinkling and rolling shall continue until a wagon with 2-in. tires and carrying not less than 2 cu. yds. of stone can be hauled over it without making an appreciable rut." There is no mistaking the meaning of the clause.

I always advocate a roller of not less than five tons weight, and prefer a horse roller. If the rock is an extremely hard material and does not bind well, then a heavier roller can be used. I may be peculiar in my preferences, but my experience with extremely heavy steam rollers has not been all that could be desired. In most cases there is too much crushing of the material. If the contractor possesses a heavier roller than five tons, and, in my opinion, the material can stand it, he is at liberty to go ahead.

My specifications insist upon an entire absence of clay and loam in the metalling, but there is such a thing as going to the extreme in screening. Doubtless, Macadam and some of the European engineers could succeed in doing without binder. I suppose tires are much wider abroad than in this country and loads are heavier, and under the influence of the traffic and with constant repairs a road of fair sized stones without binder ultimately becomes first-class. Here, we must face the fact that tires are narrow, and the authorities will seldom spend ten cents for maintenance inside of three years. Binder is therefore a necessity. But it is best if of the same material as the macadam. My specifications generally call for three layers; the first of rock, not more than 4 ins. and not less than 2 ins. in any dimension; this layer is to be one-half the total thickness of the finished coating. The second layer is one-third the thickness of the coating, and of rock not more than 2 ins. nor less than 1 in. in any dimension. The third layer to complete the coating must contain rock of the same dimensions as the second layer. With respect to the proportion of the sizes, the specifications call for "no more fine stuff and dust than is unavoidable and for not less than 75% of the rock in the second and third layers to exceed 1 in. in every dimension, and the pieces to be as nearly as practicable cubical in shape."

All inspectors are not capable men, and I have never yet had one who was. Generally, on each improvement, the property owners who pay for it have a preference for some certain man as inspector. It is not good policy to give way always; and yet, if the authorities cannot see that it is for their own good to have capable men as overseers, they have to pay the bills, and must suffer for their own misdeeds. It is not meant that an entirely incompetent inspector will be employed, for no engineer would permit that on work he oversees; but some inspectors must be engaged who would cool their heels a long time in front of a saloon before any engineer would tolerate them, if he were entirely his own master. But some concessions must be made, or the road will be built without an engineer.

With respect to trenches in the roadway, I have had poor luck with trenches in which the water was poured during the process of filling, principally on account of the quality of the inspection service. If the soil is sandy, it will stand the wetting, and the subsequent settling will be slight. If it is all sand, then the more water the better. But if there is no sand, or the material is a clay, my specifications provide that the material alongside the trenches must be wet thoroughly and allowed to stand for at least ten hours after the wetting before being put back in the trench. This gives an opportunity to permit surplus water to escape, and the quantity of moisture applied does not depend upon the inspector. The more water, the more it will cost to place the dirt in the trench, and the contractor soon learns to apply very little water. The less water, the better, and yet we cannot dispense wholly with it. With some experience, the inspector can soon determine whether it is necessary to wet the filling, as oftentimes it is moist enough as it comes out of the trench and can be put back very soon. The object is to get the material to pack well without future settling and not to see that the earth is wet, simply because the specifications provide a particular method of moistening it. I have never had any appreciable settlement where the excavated material was first moistened outside the trench.

Specifying rigidly the size of the stone gives the inspector an opportunity to bleed the contractor, and gives the contractor an opportunity to slight his work after submitting to the bleeding process. To permit a reasonable amount of selected sizes and not rigidly exclude fine stuff, what the contractor and the inspector and the property owners term reasonable latitude is permitted, and a good job is assured. In this way we can make another allowance for inexperience, or incompetency (relative terms). I have found that too rigid specifications have a tendency to either rattle an honest inspector, or they give a dishonest one an opportunity to strike a bargain with a contractor. In the first case, it either results in a poor job, or a cinched contractor; and in the latter case we have both.

Yours truly,
Ernest McCullough.

San Francisco, Cal., Dec. 23, 1897.

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Stream Flow in Relation to Forests.

Sir: In your issue of Jan. 6 you give a very satisfactory summary of the papers of Mr. Rafter and myself on the subject of stream flow in relation to forests, but in your editorial of the same date, while your statements cannot be said to be incorrect, I think possibly there may be a tendency to perpetuate one or two errors made by Mr. Rafter in relation to my own work. At present I have to deal only with two points.

Mr. Rafter makes the error of stating that I have relied mainly upon the short records obtained in New Jersey. He says (p. 142, Proceedings of the American Forestry Association, Vol. XII.): "In proving this proposition Mr. Vermeule depends upon data derived mostly from observations in New Jersey." He criticises these records as being too short, and the area of the state as being too small for accurate conclusions to be reached, but in the introduction to my "Report on Water Supply," p. 1, I fully set forth the fact that I did not rely on these short records for any conclusions, but merely used them for corroboration purposes and for ascertaining certain minor characteristics of the streams. Such is my attitude all through my reports. My conclusions are based on all the long series stream measurements of known accuracy which were available at the date of writing, for the Eastern United States, with some corroboration examples cited for Western streams. My general conclusions are reached on p. 100 of the report, before any New Jersey gagings are taken up for discussion, excepting the 17-year series on the Passaic, which, in my opinion, is as good as any of the others, excepting possibly the Sudbury. Continuing my studies in the "Annual Report of the State Geologist of New Jersey," for 1895, p. 147, it will be noted that I cite several long series gagings outside the State of New Jersey, and my analysis shows conclusively that these long series gagings are the ones which show the closest agreement with my conclusions.

It is true that Mr. Rafter cites a longer record on the Sudbury than that used by me, but the average rainfall and runoff for this longer period are almost identical with the averages for the period used by me. Nor does his citation of the Mystic and Cochituate gagings in the slightest shake my conclusions. Certain well-known physical facts as to those water-sheds, if properly allowed for, account for most of the discrepancy between those streams and the Sudbury, and I will also call attention to the fact that the gentlemen who are most conversant with the reliability of these three series of gagings, depend upon the Sudbury alone for their conclusions, usually. I will also say that the increased length of period on the Croton is not conducive to increased accuracy, if used without proper allowances and corrections being made. Mr. Rafter seems to have used most of his data without such discrimination as an intimate knowledge of the various streams would point out as absolutely necessary to correct conclusions. The Croton figures which he uses are based on 338 sq. miles of catchment. These are the figures taken from the old survey of the watershed made in 1858, and I presume the department has continued to use this area as a matter of convenience until the proper time comes to make corrections, but a careful geodetic survey of the Croton watershed, made under the direction of the late William E. Worthen, is on file in the office of the Aqueduct Commission, and a reduced copy of the same is printed in their last general report. This survey makes the area 353.1 sq. miles, as stated in my report, or 4% larger than that given by the old traverse survey. To anyone familiar with large scale survey operations it is perfectly clear that a survey based on a careful triangulation and laid down on a true geodetic projection will give areas far more accurate than can possibly be obtained by a mere traverse. This error alone gives a difference of 4% in the depth of runoff expressed in inches, making a necessary correction of fully 1 in. to the figures used by Mr. Rafter. It may be said, incidentally, that the superior character of the surveys of the watersheds available for New Jersey streams, over those available for many of the other streams cited by Mr. Rafter, is a decided advantage in their favor. The area of many of his watersheds is quite imperfectly known, and an error of 5% or even 10% is quite possible. I may also state, as illustrative of the need of careful discrimination in the use of records, that owing to the rapid increase of artificial storage on the Croton and the exposure of larger areas of water surface and other modifying effects upon the runoff, it is impossible to make any satisfactory analysis, year by year, of the later gagings, or to draw conclusions which will be strictly accurate when applied to watersheds in their natural condition. Furthermore, a careful analysis of some of the earlier years of the series is enough to convince anyone that the records for these years must be rejected.

The next point refers to the use which I have made of experimental determinations of evaporation abroad. Mr. Rafter takes the ground that I have wilfully ignored all of these, and you say in your editorial: "On this account Mr. Vermeule is perhaps at a disadvantage, not so much in the matter of records as in that he relies wholly upon his records, while Mr. Rafter takes into account certain results obtained by experiment and observation in fields which he believes to be allied closely to the main subject." Now, the facts are that pp. 32 to [illegible] of my "Report on Water Supply" are taken up with a presentation of considerable data of this character, including the same Risler table quoted by Mr. Rafter. Again, on p. 330 of my report I refer the reader to the paper of M. Becquerel, and I say with reference to it:

> It may be said here that this paper admirably digests and draws all the legitimate conclusions possible from experimental data obtained under the usual conditions and we prefer to refer the reader to these and other parts of Mr. Hough's report rather than quote extensively from experiments upon evaporation from soil in forests and open country, and similar observations which we do not believe are applicable to our problem.

It is significant that this admirable "Report upon Forestry," by Franklin B. Hough, of this state, summarizes in a very practical way the more valuable European data referred to by Mr. Rafter, and I think the ordinary reader will not find the citation less useful from the fact that it refers to a well-known and generally accessible report. I again call attention to this citation on p. 342 in the special chapter on the effect of forests upon stream flow. In view of all this it can scarcely be said that I have ignored such data. What I have done is to give it its proper weight and value in reaching my conclusions. Looking broadly at the question, what we desire to know is the total evaporation from a stream catchment, or the total loss of water. I was driven to adopt this method of determining the runoff of a stream from the rainfall because evaporation follows fairly well ascertained laws, so that it is possible to deduce some general law covering evaporation from stream basins, whereas the runoff of a stream is simply a residuary product or a means of providing for the surplus rainfall which is not evaporated. The problem, therefore, with relation to forest areas is, What is the total evaporation from such areas? The question as to how the evaporation beneath the trees of a forest compares with that in the open ground outside of a forest, is one which seems to me entirely foreign to our problem. The most ordinary observer knows, for instance, that a leafy forest when dry will drink up quite a shower of rain, and none will reach the earth at all. For our purposes all this rain is evaporated or lost. Again, while the evaporation beneath the trees is unquestionably less than it is in the open, how much water is taken up through the trunks of the trees to be exhaled from the leaves and branches into the air above the tree tops? It ought to be evident without further discussion that there is a large amount to be added to the evaporation beneath the trees in order to ascertain the evaporation above the tree tops into the atmosphere. To base conclusions upon this class of experimental data, therefore, would have been most unwarrantable and unscientific. As to the other class of measurements, such as those of Von Wex, giving the height of rivers for long series of years, I have given a good deal of study to them, and can only say that to my mind they are entirely inconclusive. They are certainly far less reliable than the better records of stream runoff with contemporaneous rainfall which are available to us. In my "Report on Water Supply," pp. 235 and 236 will be found an exposition of the fallacies growing out of a similar attempt to compare the previous and the present heights of the Delaware River. Again, turning to my diagram of rainfall, p. 13, please note the long cycle from 1825 up to 1869, during which, as a rule, the rainfall in the Eastern United States was gradually increasing, and this was followed by a sharp decrease to 1880. Now, suppose the height of a river had been kept for this period from 1825 up to 1869 without contemporaneous measurements of rainfall upon its watershed, what conclusion could have been reached of any value?

When a favorable opportunity presents itself I shall have very much more to say with reference to many points touched on by Mr. Rafter. I have for some time intended to make a fuller exposition of this subject, such as you no doubt will recognize it would not have been proper to enter into in an economic report, intended as a hand-book for the use of the people of New Jersey, and not as a treatise on the subject.

C. C. Vermeule.

203 Broadway, New York, Jan. 7, 1898.

Notes and Queries.

W. M. B., Newcomerstown, O., asks why all the silk mills of the country are located in the East? So far as our information extends, it is for the same reason that Gloversville, N. Y., and Plymouth, N. H., are the centers of glove manufacture, that a few Massachusetts towns have up to a few years ago made a large proportion of the boots and shoes which the country requires, that the wools grown in the far West are used in the mills of New England and the Middle States; and a number of similar examples might be given. To the establishment of such an industry as silk manufacture, a prime necessity is a supply of skilled labor; a second necessity is men of enterprise familiar enough with the industry to undertake its promotion, and last but not least is sufficient knowledge of the industry by local investors to induce them to furnish capital for it.

W. W. V. asks:

Will you please advise me how much clearance there is under the bridges over the Erie Canal; also what toll is charged on loaded steamers?

The clearance under the bridges of the Erie Canal is 12 ft. No tolls have been charged on the New York State Canals since 1880.

* * *

TESTS OF CAST-IRON COLUMNS BY THE DEPARTMENT OF BUILDINGS OF NEW YORK CITY.

We present herewith a report of the tests of full-sized cast-iron columns recently conducted by the Department of Buildings of New York city at the works of the Phoenix Bridge Co., Phoenixville, Pa., under the direction of Mr. W. W. Ewing, of the Department. The tests began on Dec. 15 at 1 p. m., and were finished on Dec. 21. The machine used was the well-known hydraulic testing machine, at the Phoenix works, a full description of which was given in Engineering News of Jan. 10, 1891. It is the most powerful testing machine in the world. To ensure the accuracy of the tests the Building Department arranged a comparison of the Phoenix machine with the famous Emery machine in the U. S. Arsenal, at Watertown, Mass. On Dec. 30-31, 1896, a series of compression tests was made at Watertown upon a soft steel Phoenix column built by the Phoenix Iron Co. especially for these tests. It was made of eight segments riveted together, forming a round column 21 ft. long, inside diam. 14⅝ ins., thickness of metal 1⅛ ins., area of section 75.3 sq. ins., total weight of 5,485 lbs. The calculated safe load was 530 tons. The column was shipped to Watertown Arsenal and carefully tested in the government machine shops at that place (Fig. 1). Marks were made 26 ins. from the ends, that is, 200 ins. between marks, and a form of roller extensometer (Fig. 2), reading to 1-10,000 in., was employed, to take all measurements. In applying the load constant increments were used. Certain additional loads were applied, corresponding with those to be applied later in the Phoenix machine. The column was then returned to Phoenixville, and the tests repeated in the Phoenix machine. The conditions were reproduced as nearly as possible; the same series of readings were taken, using the same extensometer. The results of the two tests are shown in Tables I. and II.

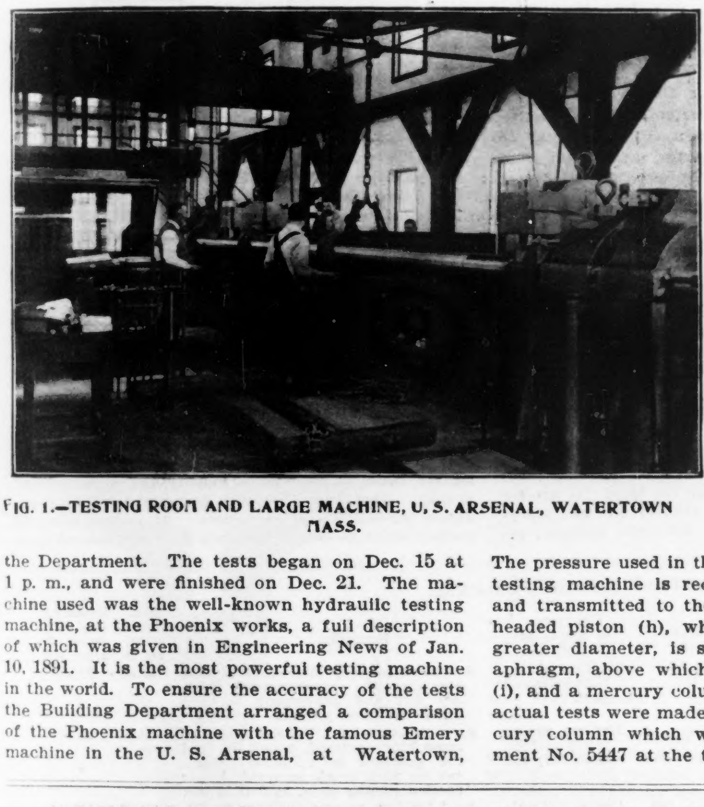

FIG. 1.—TESTING ROOM AND LARGE MACHINE, U. S. ARSENAL, WATERTOWN MASS.

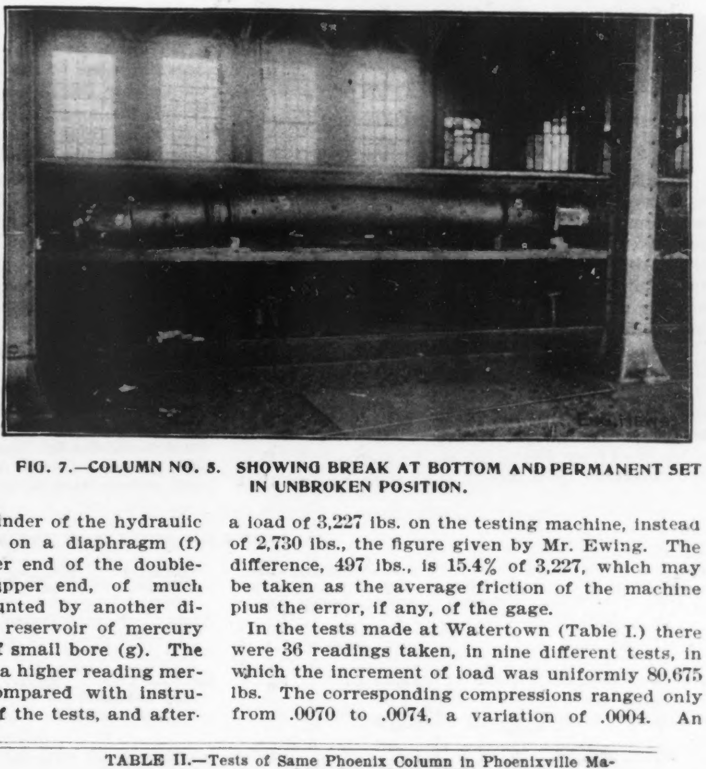

FIG. 7.—COLUMN NO. 5. SHOWING BREAK AT BOTTOM AND PERMANENT SET IN UNBROKEN POSITION.

The gage used to calibrate the Phoenix machine was a mercury column instrument, manufactured by Thomas Shaw, of Philadelphia, Pa., and numbered 5447, was calibrated to read in pounds per sq. in., and ranged from 0 to 220 lbs. Fig. 3 is a sectional view of the lower portion of the gage. The pressure used in the cylinder of the hydraulic testing machine is received on a diaphragm (f) and transmitted to the lower end of the double-headed piston (h), whose upper end, of much greater diameter, is surmounted by another diaphragm, above which is a reservoir of mercury (i), and a mercury column of small bore (g). The actual tests were made with a higher reading mercury column which was compared with instrument No. 5447 at the time of the tests, and afterwards by the maker of both instruments. The values in Tables I. and II. have been corrected in accordance with the result of the calibrations.

From the figures given in Tables I. and II. the following computation of the calibration of the Phoenix testing machine was made and included in Mr. Ewing's report:

Let P = unit load in Watertown machine.
l = compression in ins. due to P.
P' = unit load in Phoenix machine.
l' = compression in ins. due P'.
$P = 1$ lb., $l = .0000000891$, and $l' = .0002432916$.
If $P : P' = l : l'$

$$\text{then } \frac{P}{P'} = \frac{l}{l'}, \text{ and } P' = \frac{P\,l'}{l}.$$

$$P' = \frac{.0002432916}{.0000000891} = 2{,}730.54 \text{ lbs.}$$

This figure indicates that each unit on the gage must be multiplied by 2,730. to obtain the pressure exerted in lbs.

We would call especial attention to the importance and value of the above test as furnishing for the first time, so far as we are aware, an accurate calibration of the Phoenix hydraulic machine.

According to the illustration of the Phoenix machine in our issue of Jan. 10, 1891, the hydraulic cylinder is bored to a diameter of 64.1 ins. This is equivalent to an area of 3,227 sq. ins. If there were no friction in the machine and no error in the Shaw mercury column gage, then 1 lb. pressure per sq. in. indicated on the gage would represent a load of 3,227 lbs. on the testing machine, instead of 2,730 lbs., the figure given by Mr. Ewing. The difference, 497 lbs., is 15.4% of 3,227, which may be taken as the average friction of the machine plus the error, if any, of the gage.

In the tests made at Watertown (Table I.) there were 36 readings taken, in nine different tests, in which the increment of load was uniformly 80,675 lbs. The corresponding compressions ranged only from .0070 to .0074, a variation of .0004. An

TABLE I.—Tests of Phoenix Column in Watertown Machine, Dec. 30—31, 1896.

No.	Total load, lbs.	Compressions in ins.								
		No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	No. 9.
1.	161,150	0.0091	0.0088	0.0084	0.0081	0.0085	0.0068	0.0057	0.0058	0.0057
2.	322,700	.0233	.0229	.0226	.0221	.0220	.0207	.0200	.0199	.0200
3.	403,375	.0304	.0302	.0298	.0292	.0292	.0278	.0272	.0272	.0271
4.	484,050	.0375	.0372	.0370	.0365	.0364	.0349	.0345	.0345	.0345
5.	564,725	.0446	.0444	.0441	.0437	.0435	.0420	.0418	.0417	.0418
6.	645,400	.0519	.0518	.0515	.0510	.0506	.0493	.0490	.0490	.0490
7.	763,720	.0626	.0625	.0622	.0617	.0613	.0600	.0597	.0597	.0597

Differences.

Nos.	Loads, in lbs.	Compressions in ins.								
1—0.	161,150	0.0091	0.0088	0.0084	0.0081	0.0085	0.0068	0.0057	0.0058	0.0057
2—1.	161,550	.0142	.0141	.0142	.0141	.0135	.0139	.0143	.0141	.0143
3—2.	80,675	.0071	.0073	.0072	.0071	.0072	.0071	.0072	.0073	.0071
4—3.	80,675	.0071	.0070	.0072	.0073	.0072	.0071	.0073	.0073	.0074
5—4.	80,675	.0071	.0072	.0071	.0072	.0071	.0071	.0073	.0072	.0073
6—5.	80,675	.0073	.0074	.0074	.0073	.0071	.0073	.0072	.0073	.0072
7—6.	118,320	.0107	.0107	.0107	.0107	.0107	.0107	.0107	.0107	.0107

Average differences.

Nos.	Loads, lbs.	Compressions, ins.	Compression in ins. per lb.
2—1.	161,550	0.014,066,66	0.000,000,087,0
3—2.	80,675	.007,177,77	.000,000,088,9
4—3.	80,675	.007,211,11	.000,000,089,3
5—4.	80,675	.007,177,77	.000,000,088,9
6—5.	80,675	.007,277,77	.000,000,090,2
7—6.	118,320	.010,700,00	.000,000,090,4

Average compression in ins. per lb. of load, 0.000,000,089,1.

TABLE II.—Tests of Same Phoenix Column in Phoenixville Machine, Dec. 15—16, 1897.

No.	Loads, gage read'g.	Compressions in ins.							
		No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.
1.	60	—0.0095	—0.0091	—0.0097	—0.0090	—0.0096	—0.0089	—0.0096	—0.0089
2.	100	.0003	.0004	.0002	.0005	.0003	.0005	.0002	.0007
3.	125	.0059	.0061	.0059	.0062	.0057	.0062	.0060	.0063
4.	150	.0118	.0122	.0118	.0123	.0117	.0122	.0117	.0122
5.	175	.0181	.0186	.0179	.0187	.0180	.0187	.0182	.0188
6.	200	.0235	.0247	.0237	.0248	.0238	.0247	.0240	.0247
7.	220	.0292	.0303	.0288	.....	.0289	.....	.0289	.....

Differences.

Nos.	Loads, scale divisions.	Compressions in ins.							
1—0.	60	0.0095	0.0091	0.0097	0.0090	0.0096	0.0089	0.0096	0.0089
2—1.	40	.0098	.0095	.0099	.0095	.0099	.0094	.0098	.0096
3—2.	25	.0056	.0057	.0057	.0057	.0054	.0057	.0058	.0056
4—3.	25	.0059	.0061	.0059	.0061	.0060	.0060	.0057	.0059
5—4.	25	.0063	.0064	.0061	.0064	.0063	.0065	.0065	.0066
6—5.	25	.0054	.0061	.0058	.0061	.0058	.0060	.0058	.0059
7—6.	20	.0057	.0056	.0051	.....	.0051	.....	.0049	.....

Average differences.

Nos.	Loads, scale divsn.	Compressions. ins.	Compression in ins. per unit of gage rdg.
2—1.	40	0.00967	0.000,241,75
3—2.	25	.00565	.000,226,00
4—3.	25	.00595	.000,238,00
5—4.	25	.00639	.000,255,6
6—5.	25	.00586	.000,234,4
7—6.	20	.00528	.000,264,0

Average compression in ins. per unit of gage reading, 0.000,243,291,6.

TABLE IV.—Compression Tests of Cast-Iron Columns made for the Department of Buildings, New York city, in 1896, by Gus. C. Henning, M. Am. Soc. M. E.

No.	Length.	Outside diameter, ins.	Thickness. Maximum.	Thickness. Minimum.	Thickness. Average.	Breaking load, actual gage-reading. lbs.	Sectional area, sq. ins.	Breaking load per sq. in., lbs.	*Corrected breaking l'd per sq. in.
1.	147¾ ins.	8	13-16	⅝	¾	520,000	17.08	30,400	25,840
2.	150 "	9	1⅛	¾	1	630,000	25.14	25,100	21,340
3.	162 "	12	1	1	1	1,250,000	34.55	36,200	30,770
4.	159¾ "	14	1⅛	¾	1	1,226,000	39.84	30,700	26,100

*The figures in this column are obtained by deducting 15% from those in the preceding column, for friction of the machine.

inspection of the figures seems to indicate that this variation was that of the measuring instrument and of the personal equation of the observer, rather than an error in the recording of the load by the testing machine, or a variability in the action of the column being tested. The differences in the recorded compressions due to the first applied load, 161,150 lbs., in the nine tests, ranging from .0057 to .0091 ins., is probably an error in the setting or in the zero reading of the measuring instrument, which error remained practically constant during each one of the tests, and does not affect the increments of loads after the first load.

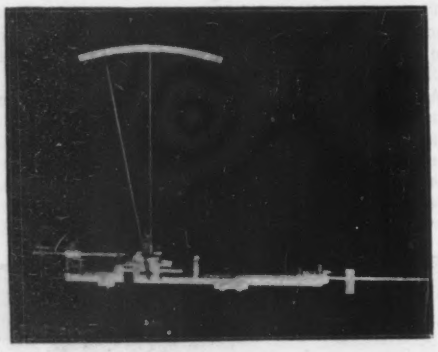

Fig. 2.—Reading End of the Roller Extensometer Employed in the Calibration Work.

In the calibration of the Phoenix machine the compressions due to increments of 25 units on the gage (or 25 × 2,730 = 68,250 lbs.), range from .0054 to .0065 in., a difference of .0011, which is nearly three times the range shown in the Watertown tests for an increment of load of 80,675 lbs. If we assume that the whole range of difference found in the Watertown tests, .0004 in., is the error of the measuring instrument and the personal equation in reading it, and subtract it from .0011 in., the difference, .0007 in., seems to be due to a variable error, due to variable friction, in the Phoenix machine. Taking the compressions due to an increase of the load from 100 to 200 on the gage (Table II.), or 273,000 lbs. in 10,000ths of an inch, we find that in the eight tests they were, respectively, 232, 243, 235, 243, 235, 242, 238, 240, averaging .02385 in.; the lowest figure (232) being .00065 in., or nearly 3% below, and the highest (243), .00045, or 2% above the average. The figure .02385 ÷ 100 = .0002385 in., seems to us to be a more correct figure for the average value of the compression due to the unit gage reading, than the figure .000243 given in the report, and this figure gives 2,675 lbs. instead of 2,730 lbs. as the load corresponding to a 1 lb. pressure per sq. in. per division recorded on the gage. Comparing this value with the area of the cylinder of the testing machine 3,227 sq. ins., gives an average friction of 17.1%, instead of 15.4%, as computed above. According to the calibrations the friction may vary from the average as much as 3% in the case of loads of 273,000 lbs., the variable percentage being greater the smaller the load. The figure of 2,730 lbs. given in the Building Department report, may be accepted as being probably the highest value of the actual load corresponding to 1 lb. per sq. in. indicated on the gage, the actual load in some instances being probably 5% less than that computed from the gage reading, in the case of the lighter loads, and, say, 3% less in the case of the heavier loads.

We come now to consider the results of the breaking tests of the cast-iron columns. Ten columns were tested, six of them (Fig. 4) being 15 ft. 10¼ ins. long, 15 ins. diameter, and from 1 to 1 3-16-in. thick; two (Fig. 5) were 13 ft. 4 ins. long, 8 ins. diam., and two were 10 ft. long and 6 ins. diameter. A condensed table of results, Table III., is given herewith, the last two columns of which are from our own calculations and are not given in the Building Department report, which gives only the actual data obtained without drawing any conclusions.

From the observations reported by Mr. Ewing, we quote as follows:

> Column I.—Column suddenly broke under a total load of 1,356,000 lbs. into 10 pieces; the fractured surface began about 3 ft. 4 ins. (average) from the bottom.
>
> The quality of metal was medium grain; foundry dirt and blowholes were quite numerous; in one place the foundry dirt extended half way through the metal; in another place, there was a thin layer of foundry dirt and honeycomb midway between the inner and outer surfaces; between this layer and the two surfaces, the metal was perfectly sound; this layer of foundry dirt contributed to the weakness of the column as was evident from an inspection of the fractured surface.

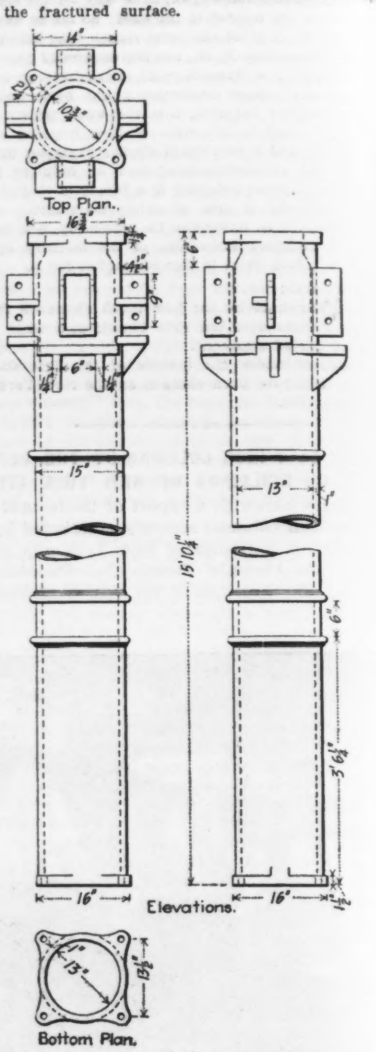

Fig. 4.—Details of the 15-in. Columns.

> The column sheared at an angle of about 30° with an element of the surface, and about 45° with a normal to the surface, inside of the layer of foundry dirt, above referred to only. This layer of foundry dirt extended about 6 ins. around (circumference) on column. At another fractured surface where no defects occurred, the metal sheared along

TABLE III.—RESULTS OF BREAKING TESTS OF CAST-IRON COLUMNS.

Column No.	Length.	Outside diameter.	Thickness. Maximum.	Thickness. Least.	Thickness. Average.	Location of break.	Breaking load, lbs.	Compression.	Character of metal at fracture.	Remarks.	Sectional area, sq. in.	Breaking load per sq.in. of area, lbs.
I.	190¼ ins.	15 ins.	1	1	1	About 3 ft. 4 ins. from bottom.	1,356,000	......	Medium grain; blowholes and dirt.	One place foundry dirt extended half way through; another place foundry dirt and honeycomb between inner and outer surface.	43.98	30,830
II.	190¼ ins.	15 ins.	1 5-16	1	1⅛	Bet. 1 and 5 ins. from bottom.	1,330,000	......	Medium grain; fairly unifrm, spots fdry drt	At a pressure of 1,302,000 a slip of some kind occurred, which dropped the pressure to 1,275,000; again run up until break occurred. Upper portion sprung ½-in. in 9 ft. 4 ins.	48.03	27,700
B 2.	190¼ ins.	15 ins.	1¼	1	1⅛	Bet. 3¾ ft. from bot'm and 6½ ft. from top.	1,198,000	2½ ins., bet. 150,000 and 1,108,000.	Coarse, but uniform; a few flaws.	At 1,108,000 column sprung badly, Fig. C; movement recorded under compression.	48.03	24,900
B 4.	190¼ ins.	15⅛ ins.	1 7-32	1	1⅛	Bet. bot'm and one-third up from bottom.	1,246,000	2¼ ins., bet. 150,000 and 1,246,000.	Coarse in center; finer on outside; cinders and slag.	Bad spots, cinder pockets and blowholes near middle of column; small cracks in necking near top; column given a permanent set.	49.48	25,200
5.	190¼ ins.	15 ins.	1 11-16	1	1 11-64	At bot'm flange.	1,632,000	2 5-16 ins. in 8 ft. 3 ins.	Fine grain and unif'rm where no flaws occurred.	Flaws and foundry dirt at point of break; load was carried as high as 1,804,000. The dummy head against which column rested was found broken after the test; this may have had something to do with character of break.	50.84	32,100
6.	190¼ ins.	15 ins.	1¼	1⅛	1 3-16	No break; permanent set of 1 3-16 ins. in 8 ft.	Over 2,082,000	⅝-in. betw'n 232,000 and 1,108,000.	No break.	Pressure run up to 1,108,000 and released. It was again run up to 2,082,000, released and run up to 2,033,000. Column could not be broken; capacity machine reached.	51.52	Over 40,400
XVI.	160 ins.	Bet. 8¼ and 7¾ ins.	1¼	⅝	1	Where chaplet was placed at middle, and at ends.	651,000	......	Metal g'd; medium grain.	At time of breaking, column had a vertical deflection of 3 9-16 ins. and a horizontal deflection of 1⅛ ins.; fracture seemed due to flexture.	21.99	31,900
XVII.	160 ins.	8 ins.	1 3-32	1	1 3-64	At middle and ends.	612,800	......	Fine grain, uniform and free from flaws.	Vertical deflection, 4¼ ins.; horizontal, 7-32-in.	22.87	26,800
7.	120 ins.	6 1-16 ins.	1 5-32	1⅛	1 9-64	At middle and each end.	400,000	......	Good even gr'n, no flaws.	Vertical deflection 3¼ ins.; horizontal deflection, 1 11-32 ins.	17.64	22,700
8.	120 ins.	6 3-32 ins.	1⅛	1 1-16	1 7-64	At middle and each end.	455,200	......	Fine grain, uniform and free from flaws.	Vertical deflection, 3 ins.; horizontal deflection, ⅝-in.	17.37	26,300

a spiral course about 45° with an element of the surface, and at an angle of 45° with a normal to the surface: this surface was about 15 ins. long.

Column II.—The column crushed near the lower end, many of the pieces being quite small; the bottom flange was left intact, the fractured surface beginning at the top of the flange or 1¾ ins. from the faced end of the column and extending around the shaft in an irregular manner reaching 5 ins. away from bottom flange in one place.

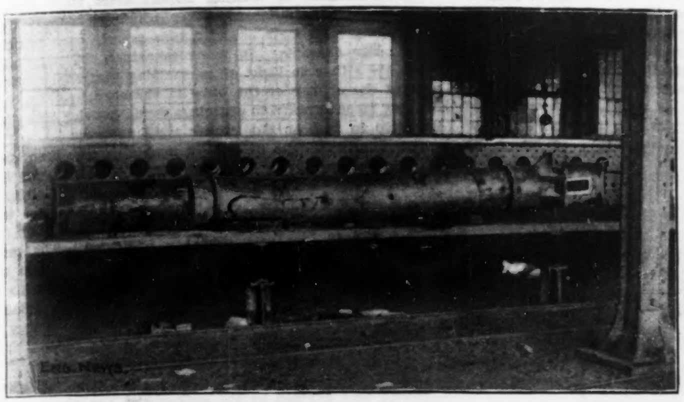

FIG. 6.—COLUMN B 4. SHOWING FRACTURE NEAR CENTER.

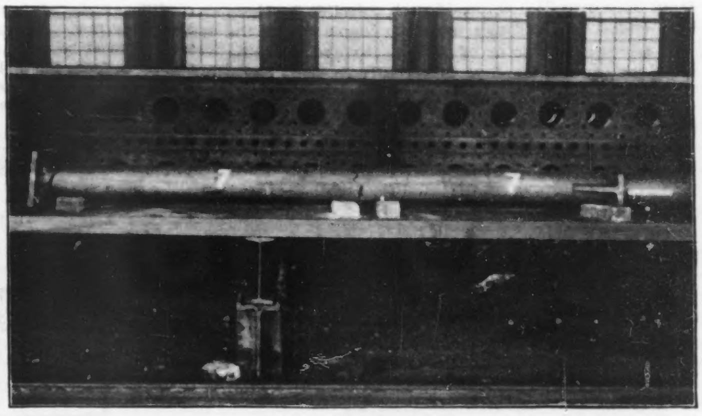

FIG. 8.—COLUMN NO. 7. SHOWING BREAK AT ENDS AND MIDDLE OF 6-IN. COLUMN.

The shaft of the column above the fractured portion was found to be permanently sprung ½-in. in a distance of 9 ft. 4 ins. along shaft. The quality of metal at bottom of column, where fracture occurred, was medium grain and quite uniform in grain. Considerable quantities of foundry dirt was found at fractured surfaces and where the column crushed into small pieces, the foundry dirt extended all the way through in many spots.

The shaft sheared in several places at an angle of about 45° to the elements of the surface of the column parallel with its axis, the fractured surface following a sort of spiral path around the shaft. The metal at the same time sheared through at an angle of from 30° to 45° with a normal to the surface of column.

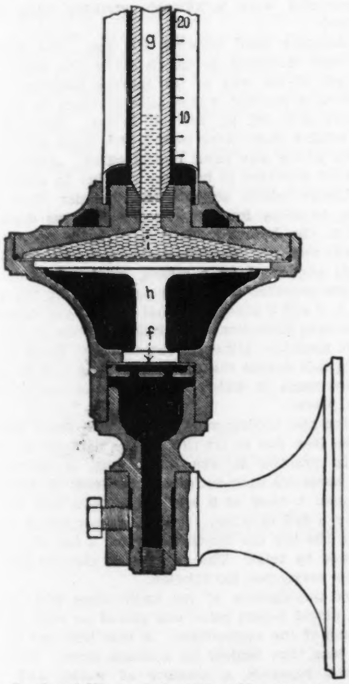

Fig. 3.—Sectional View of the Shaw Mercury Gage used at Phoenixville.

Column B 2.—The fractured portion of column was below the center, beginning 3 ft. 9 ins. from bottom and 6 ft. 6 ins. from top of column.

Quality of metal, rather coarse, but quite uniform. Flaws occurred in spots, but not bad. There was evidence of shear at 45°, the same as in preceding columns.

Column B 4 (Fig. 6).—The quality of metal was rather coarse in center of shell, and somewhat finer toward the surfaces. Cinders and slag in considerable quantity, two bad spots nearly opposite at bottom of column where metal was poor; one of these was 5 ins. long on outside (around column) and extending about half way through the metal. On the opposite side the defective portion was 4 ins. wide on inside, and extended for one-third to two-thirds the way through the metal. There were indications of shear at about 45°, similar to cases previously noted, at the bottom, where the column broke into small pieces.

The total number of pieces was 15.

The fractured surfaces revealed many cinder pockets and blowholes near middle of column. Small cracks were observed in the necking near top of column.

Column 5 (Fig. 7).—Column broke into 14 pieces; all fractures occurred below the lower necking on column and broke through bottom flange. The permanent set in the shaft between the upper and lower necking was 2 5-16 ins. in 8 ft. 3 ins.; the upper part of the shaft above the necking remained perfectly straight after the test. Flaws were found in fractured surfaces near bottom, of foundry dirt. One bad flaw about 5 ins. wide and 4 ins. high (long) on outside extending three-fifths of the way through.

Quality of metal was rather fine grain and very uniform where no flaws occurred. Part of the shaft remained intact to end, and part of flange was left on. After the test, it was found that a dummy head against which the end of the column bore, was broken in such a way that the load on the column was eccentric after the head gave out; the nature of the fracture sustains this belief.

Column 6.—The test was discontinued when a load of 2,033,000 lbs. had been reached, the capacity of the machine having been reached. The permanent set of the column after it was removed from the testing machine was 13-16-in. in a length of 8 ft. 5 ins. The concave side, after the test, was about 90° from the joints of the flask, and undoubtedly was the top of the column as cast in the mold.

Column XVI.—One fracture occurred at a point where the chaplet for holding down the core was imbedded into the metal of the column. The metal outside of the chaplet was ⅞-in. thick, and the chaplet 3-16-in. metal. The cast metal did not adhere to the chaplet.

The column broke into 6 pieces (at middle and at each end). The fracture at the middle was nearly square off, and very near the exact middle point between the two ends. The fractures were about 1 ft. from each end and irregular in outline.

The metal was good, of medium grain. Wires were attached to the shaft of the column, 6 ft. 6 ins. from bottom, and ran perpendicular to the axis of the column, one horizontally and one vertically. These were carried to the outside of the building in which the tests were being made, and the actual vertical and horizontal deflections of the column were observed in conjunction with the corresponding loads.

There was no evidence of shear at the fractured surfaces, as in the case of the larger columns. Failure seemed to result primarily from flexure.

Column XVII.—The column broke into 8 pieces, the fractured points being at the middle and near each end.

Quality of metal at fractured surfaces was fine grain, uniform and free from flaws.

Column 7 (Fig. 8) was broken into four pieces, the fractures being 3 ins. to one side of the middle of the column and near each end. The quality of the metal was good, even medium grain, with no flaws.

Column 8.—The quality of metal was fine grain, uniform and free from flaws. The column broke into four pieces, fractures being at middle and near ends; broke off nearly square at each point; no signs of shear in metal.

Two of the 15-in. columns tested, Nos. B 2 and B 4, were taken from the Ireland Building, which, it will be remembered, collapsed Aug. 8, 1895 (Eng. News, Aug. 15, 22, 29, Sept. 5, Oct. 3, 1895). The four remaining 15-in. columns were made from drawings prepared by the Department of Buildings of New York city (Fig. 4), and were as nearly as possible duplicates of the Ireland columns.

The columns marked I. and II. were made by the Jackson Iron Works, 27th St. and East River, New York city, of their ordinary run of metal. They were cast while other columns were being cast, with no knowledge of their ultimate use. The two marked 5 and 6 were made by the Healy Iron Works, Brooklyn, N. Y., who were informed of what the columns were wanted for. The drawings for the 6-in. and 8-in. columns (Fig. 5) were also made by the Department.

All the columns broken were, we understand, fair samples of the average cast-iron column used in buildings in New York city, and regularly passed by the Building Department as coming within the provisions of the law.

The Building Law of the City of New York says:

> The strength of all columns and posts shall be computed according to Gordon's formulae, and the crushing weights in pounds, to the square inch of section, for the following materials, shall be taken as the coefficient in said formulae, namely: Cast-iron, 80,000. . . . The factors of safety shall be as one to four for all posts, columns and other vertical supports when of wrought-iron or rolled steel, and as one to five for other materials, subject to a compressive strain.

Applying Gordon's formula* with the coefficient 80,000, as above required, in the numerator, and 400 (which is not given in the law, but is given in Haswell's Pocket Book, to which reference is made) in the denominator, we have

$$S = A \frac{80,000}{1 + \frac{l^2}{400\ d^2}}$$

in which S is the breaking load, A = sectional area in sq. ins., l = length, and d = diameter of the column in inches.

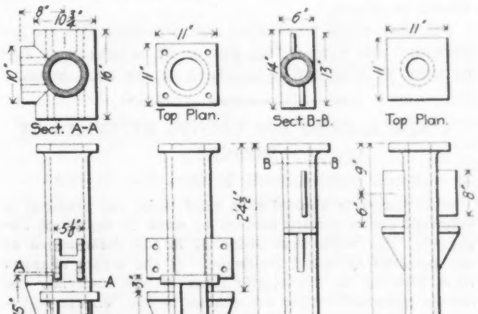

Fig. 5.—Details of the 6-in. and 8-in. Columns.

For the 15-in. columns we have l = 190 ins., d = 15 ins., S = 57,143 A. For the 8-in. columns, l = 160 ins., d = 8 ins., S = 40,000 A. For the 6-in.

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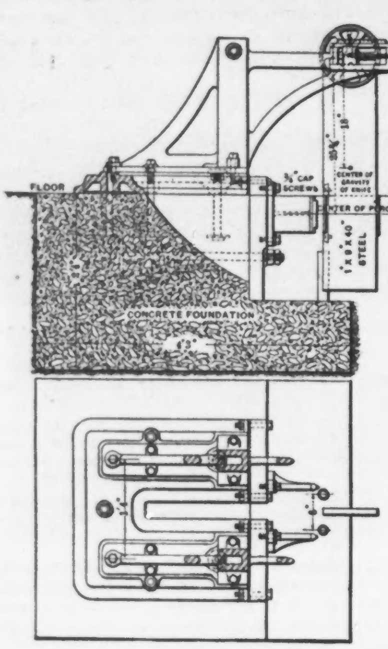
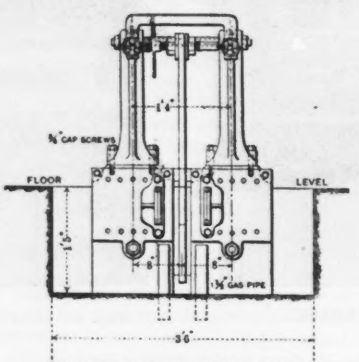
*Mechanics' and Engineers' Pocket-Book, Chas. H. Haswell, 1897, p. 768.

columns, l = 120 ins., d = 6 ins., S = 40,000 A. That is, by the New York law, the 15-in. columns would be calculated to have a breaking strength of 57,143 lbs. per sq. in., while the actual tests show that their strength was only from 24,900 lbs. to something over 40,400 lbs. per sq. in. The 6 and 8-in. columns would be calculated to have a breaking strength of 40,000 lbs. per sq. in., while their actual breaking strength was only from 22,700 to 31,900 lbs. If such columns as these are loaded in buildings with the loads which the law allows, the factor of safety, instead of being 5, as required in the law, is actually in some cases little more than 2. This is also borne out by the results obtained during similar tests conducted about a year ago by the Department of Buildings with full-sized cast-iron columns. The dimensions and results of these tests are given in Table IV. The values given in the column headed "breaking load" are in round numbers, hence the breaking loads per sq. in. of area are correct to the hundreds as given.

Further tests were made at Phoenixville to determine the supporting power of brackets, a full account of which will be given in our next issue.





Figs. 1, 2 and 3.—An Impact Machine for Testing the Resilience of Materials.
S. Bent Russell, M. Am. Soc. C. E., Designer.

* * *

A NEW MACHINE FOR TESTING MATERIALS BY IMPACT.*

By S. Bent Russell, M. Am. Soc. C. E.†

When stress is applied to a solid body, the material is distorted and a certain amount of work or energy is absorbed. The work thus absorbed in the deformation of the material is called resilience. If the stress changes from zero up to the elastic limit of the material, the energy absorbed during the change is the "elastic resilience" of the material. If the stress changes from zero up to the ultimate strength of the body, the energy absorbed is the "ultimate resilience" of the body.** The word toughness, as used by engineers, is synonymous with resilience. In fact, the latter may be defined by saying that resilience is toughness reduced to measurement.

Having defined resilience, it is next found that, as it depends upon change of stress, different results may be looked for when the stress is applied suddenly, from those obtained when it is applied slowly. The resilience under impact may not be the same as the resilience under gradual load. Again, the resilience of solids may be studied under the four principal kinds of stress, viz., tension, compression, torsion and bending. The relative resilience under these different forms of stress can only be determined by experiment.

A knowledge of the resilience of materials of construction is of the greatest importance to the engineer. It is the great resilience of the battle ship's steel armor that enables it to withstand the impact of heavy projectiles without destruction. It is the low resilience of cast-iron that makes it so inferior for railway bridges. It is on account of the high resilience of wood that it cannot, in many cases, be supplanted by masonry, glass or other decay-proof material. A concrete railroad tie cannot take the place of the oak tie because it lacks resilience.

Admitting the importance of a knowledge of resilience, a brief consideration of the difficulties to be overcome in obtaining such knowledge is naturally to be considered next. It is at once found that they are of considerable proportions. To find the strength of a beam under given conditions it is only necessary to find its weakest section and study that. To find the resilience of the beam all sections must be taken into account. If the beam is irregular in form, the problem becomes quite a difficult one. If the final stress exceeds the elastic strength of the material, the difficulties are increased.

The actual measurement of the resilience of a beam has been found quite difficult. The load must be increased gradually and the deflection measured and recorded with its corresponding load. As the breaking point is neared the difficulties of accurate work become important, especially in the more ductile materials. If the determination of the resilience by impact or drop test is attempted, other complications arise. The mass or weight of the beam itself now becomes a factor in the test. The work absorbed by the anvil and hammer and that taken up in abrasion, etc., are difficult to estimate.

To one who has a proper understanding of these difficulties in measuring resilience, it is not surprising that the subject is somewhat neglected in the studies of practical men. At present it may be said that the knowledge of comparative resilience of materials is "appreciable, but not describable." It is known that a cubic inch of oak has more resilience than a cubic inch of white pine, but the value of either cannot be expressed in inch-pounds or foot-pounds.

In modern practice, the testing of materials by impact is by no means uncommon. Such tests, however, are generally made on the finished shape, as in the case of railway axles. In a code for testing materials, recommended by committee to the American Society of Mechanical Engineers,* it was prescribed that drop tests should be made with a steel ball, weighing 1,000 to 2,000 lbs., having a clear fall of 20 ft. The anvil, block, frame, etc., should weigh not less than 10 times as much as the ball. Drop tests were recommended for rails, tires and axles. Again, the Master Car Builders' Committee,† have recommended drop tests for railway axles. These tests were to be made with a trip, weighing 1,640 lbs. The anvil should weigh 17,500 lbs., and should rest on springs. The axle should rest on supports 3 ft. apart. Cast-steel drawbars are now regularly furnished by contract, under specifications which call for drop tests of sample drawbars, specifying weight of trip, height of drop and number of blows. Drop tests of steel rails have been in practical use for many years.

Besides the above tests of finished shapes, the following methods, which are used in commercial practice, may be noted. These tests, while they do not measure the resilience so directly, are, nevertheless, intended to prove the toughness of the material. In testing cast-iron water pipe by hydraulic pressure, it is customary to strike the pipe smartly with a hand hammer while the pressure is on. In inspecting steel where a sample bar is nicked and then bent with the hammer, the behavior of the bar indicates the degree of toughness which the material will have under impact. A high percentage of phosphorus in steel is believed to reduce its ability to withstand shocks, while its strength and percentage of elongation remain unchanged.** So that it may be said that the specified chemical determinations of phosphorus in structural steel which are now in use are really indirect tests of resilience under impact.

Users of structural steel will readily see the necessity which now exists for a definite physical test for the ultimate resilience of steel under impact. It was this special necessity which led the author into the study of the subject and suggested the experiments described in this paper.

If, instead of limiting the percentage of phosphorus in the steel, a certain ultimate resilience per cubic inch of the metal when tested by impact could be called for, a step would be made in advance. If a definite resilience under impact could be specified, just as a definite strength and ductility are now called for, the proper inspection of steel would be much more simple and satisfactory.

The difficulties of making impact tests have already been suggested. Some machines which have been used for making such tests are of a type greatly open to criticism. For example: In some machines the supporting parts are either so light or so yielding that an important part of the energy of the blow is absorbed by them, and the test piece appears to sustain a much heavier blow than it would in fact on the proper rigid supports.

Two general forms of testing machine have been used in recorded tests. In Mr. Hodgkinson's experiments the hammer used was in the form of a pendulum, striking with a horizontal blow. The weight of the hammer was concentrated in the head or ball, and the effect of the rod or radius arm was probably neglected. The most common form of impact testing machine is doubtless the heavy weight falling vertically, somewhat after the fashion of the common pile-driver. In none of these machines is there any means for measuring how much energy is left in the hammer after breaking the piece.

A New Impact Testing Machine.

The machine used in making the experiments given herewith was devised by the author and has some special features.

In designing it the main idea was to make a machine which would measure the energy actually absorbed in breaking the test bar. This was to be done by using a hammer in the form of a pendulum, and so arranged that it would strike a horizontal blow, breaking clear through the bar and swinging freely up to the height due to the velocity after the impact. The difference between the height to which it rose after striking would measure the energy absorbed in breaking the bar. The test piece would rest against two vertical knife-edges and be struck in the middle by the falling pendulum, thus giving the ultimate resilience of the bar under transverse stress.

In developing this idea it was found best to make the pendulum or hammer of the very simplest form, so that the center of percussion and center of gravity could be definitely computed. The hammer adopted was a rectangular steel bar pierced by a shaft at the upper end and provided with a suitable striking edge near the lower end.

The hammer used weighed 103 lbs. The fixed knife-edges were designed so as to allow the broken bar to swing out of the way of the moving hammer, and were secured in a manner which allowed them to be adjusted for spans of 8, 12, 16, 20, and 24 ins. The heavy anvil plates behind them were bolted to a large anvil block of concrete which was sunk in the earth. Adjustable supports were provided to hold the test bar in position. The pivot blocks which support the hammer shaft are adjustable to allow for test bars of different depths. Attached to the hammer shaft is a registering device, on which the swing of the hammer is read. The pivot blocks, etc., are supported by a strong wooden frame. Attachments are provided for raising and releasing the hammer.

Figs. 1, 2 and 3 show the plans of the latest design which it is thought embodies some improvements in detail over the first machine, although the essential features are the same. In this design the frame is of iron and the operator has more room in which to work while setting the test bars in place.

In using the testing machine the first point that comes up is the loss due to friction of the hammer in its bearings. In practice it was found best to determine the friction anew for each set of experiments. If the bar was to be given a blow of 6 ins. the friction loss was determined by a fall of 6 ins. If the hammer rose 2 ins. after breaking the bar the friction loss for a fall of 2 ins. was determined by trial. The average of the two values was called the correction for friction.

To test the rigidity of the knife-edges and their supports, a nickel 5-cent piece was placed on edge on the top end of one of the knife-edges. A cast-iron test bar 2 ins. × 1 in. was then broken by a single blow. This experiment was repeated a number of times, and, in the majority of cases, the coin was not overturned by the shock.

An effort was then made to measure the movement of the knife-edge under a heavy blow. The movement was found to be so small that in the case of a cast-iron test bar, the energy absorbed by the yielding of the knife-edges would be quite inconsiderable. Every impact testing machine should be tested in this way, to see if any considerable percentage of the energy is absorbed by the yielding of parts that support the test piece.

In this method of testing materials some energy is absorbed in overcoming the inertia of the bar itself. The proportionate amount of this energy is probably dependent on the weight of the test bar compared with the weight of the hammer and also upon the velocity of the hammer.

Owing to the difficulties of ascertaining how much

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*Extracts from a paper read Jan. 5 before the American Society of Civil Engineers.

†77 East May St., St. Louis, Mo.

**This use of the word resilience will be objected to by some as not being in conformity with the original meaning of the word. It is sanctioned, however, by some authorities (see Thurston's "Materials of Engineering"), and, for want of a good substitute, may be considered as a technical term.

*See Engineering News, March 7, 1891.

†See Railroad Gazette, June 26, 1896.

**See Johnson's "Materials of Construction," pages 166 and 167.

energy is absorbed in this way, it is best to use a test-bar whose weight is small in comparison to that of the hammer. In this way the error due to inertia of the test piece can be reduced, if not eliminated.

The results of tests made to determine the effect of changing the initial fall of the hammer are somewhat contradictory, but, in a general way, it may be said that the experiments indicate that a small change in the initial fall of the hammer will not change the amount of energy absorbed, to any great degree. This conclusion may be regarded as important, as upon it depends somewhat the interpretation of all the experiments.

The machine having been described it only remains to present the experiments themselves. Over 700 specimens have been broken, up to the present writing. In order to learn the possibilities of the testing machine, the study of each material was continued only until it was thought that the principal difficulties peculiar to such materials had been overcome. It is obvious that the resilience values obtained for different materials cannot be taken as final, and should only be used by the designer in the absence of more accurate determinations.

The results of these are omitted here on account of their length, but such of our readers as are interested in obtaining them can do so by securing a copy of the Proceedings of the American Society of Civil Engineers for December, 1897. Briefly summarized, two classes of materials, viz., brittle materials, including cast-iron, brick, etc., and tough materials, including soft iron and steel, wood, bronze, aluminum, etc., were tested. With the brittle materials it was a simple matter to break the test bars, but in the case of the tough materials to break the test bar successfully, it was necessary to nick the material.

In making the impact tests, the following values are obtained by observation:

F = the initial fall of the hammer in inches.
S = the rise after the blow in inches.
C_1 = the correction for friction.
L = the distance between supports.
h = the depth of beam.
b = the width of beam.

All the dimensions are in inches.

Then, by computation, when 103 is the weight of the hammer in pounds, the resilience in inch-pounds per cubic inch of the material; or

$$R_1 = \frac{103\,[F - (S + C_1)\,]}{L\ b\ b}.$$

Table I. gives a comparison of the tests made with different materials. The values cannot be taken as typical in all cases. It will be noticed that the tool-steel, which was of good quality, tested but little better than cast-iron, and was much below the oak in value. High-grade steel is known to have little shock-resisting capacity. In low-grade steels, or steels low in carbon, it is a commonly accepted theory that a high percentage of phosphorus makes steel brittle under impact.* It may be from such a cause that some of the medium steel tested gave such low results.

TABLE I.—Resilience of Brittle Materials, in Inch-Pounds per Cubic Inch. (All tests made with rectangular beams, struck in the center and broken by a single blow.)

Material.	Resilience. R_1. Maximum.	Minimum.	Average.
Cast-iron, rough	18	10	11.5
Cast-iron, planed	22	19	21
Vitrified paving brick	3	1	1.6
Face brick, red	..	..	.26
Common brick, hard	..	..	.30
Common brick, soft	..	..	.10
Fire brick	..	..	.44
Terra cotta, red	..	..	.33
"Granitoid" (Port. cem. & crsbd granite used for sidewalks)	.30	.15	.20

TABLE II.—Resilience of Tough Materials in Inch-Pounds per Square Inch of Section at Nick. (All tests made with rectangular beams, nicked at the center and broken by a single blow.)

Material.	Resilience. R_2. Maximum.	Minimum.	Average.
Cast-iron	..	..	81.6
White oak	..	..	343
Tool steel	..	..	134
Aluminum	..	468	500
Bronze No. 85	..	673	870
Wrought-iron	..	..	1.700
Plow steel	..	1.625	1.870
Medium steel	2.150	.600	.900
Soft steel	3.600	.460	1.900
Cast steel	..	1.709	2.000

From the values of resilience for materials, given in Tables I. and II., taken together with the known specific gravity of these materials, a comparison may be made to show the relative resilience of a given weight of the different materials. Such a comparison made by the author showed that oak is the toughest material of all, where equal weights are taken. The materials may be arranged in the order of their toughness for a given weight as follows: White oak, tough steel, wrought iron, aluminum, bronze, tool steel, cast iron, vitrified brick and hard brick.

Conclusions.—The conclusions are: (1) In the case of brittle materials, definite values for resilience may be obtained. (2) In the case of tough materials like wrought iron, definite relative values for resilience of materials of the same class may be obtained.

This latter conclusion indicates that it may be specified that steel shall show a certain ultimate resilience per square inch, with a given form of nicked test-bar. Should this requirement prove satisfactory in practice, it may eventually be possible to dispense with chemical tests of steel for structural purpose.

When the proper values of resilience under impact have been determined for structural materials, designers will be able to act with more intelligence in planning structures exposed to live loads and to shocks. They will be able to substitute iron or stone for wood in certain cases with greater assurance of safety. The study of resilience will also lead to better designing in other ways. Useless material in a structure or member will generally decrease the resilience, which fact is already well known, but frequently lost sight of. The general use of resilience tests would serve to keep such facts in mind, and make them more commonly understood.

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*Johnson's "Materials of Construction," pp. 166 and 167.

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FOUNDATIONS FOR PIPE CARRIES, ETC., IN SIGNAL WORK.

In establishing signal and interlocking plants it is very desirable that substantial and permanent foundations should be provided for the pipe carriers, bell-cranks, horizontal wheels, compensators, etc., so as to maintain them in line and level, and thus prevent undue friction caused by distortion of the rods or pipes. Fig. 1 represents a style of foundation invented by Mr. Charles Hansel, M. Am. Soc. C. E., of the National Switch & Signal Co., Easton, Pa., which is believed to be in many ways superior to the ordinary style of wooden frame set in concrete. Two malleable iron supports or piers are embedded in concrete, and the tops of these are formed with T-shaped slots to take the heads of the anchor bolts. The figure shows a bell-crank on the foundation, and by means of these slots the position of the bell-crank can be adjusted or altered as desired. If it should at any time become necessary to raise the foundation (as in the event of tamping or raising the tracks), the bolts can be removed, new concrete added, and longer bolts used to connect the base of the bell-crank frame with the iron piers. The same form of foundation may be used for pipe carriers, compensators, etc., and the cost of maintenance for this iron and concrete construction will, of course, be but little.

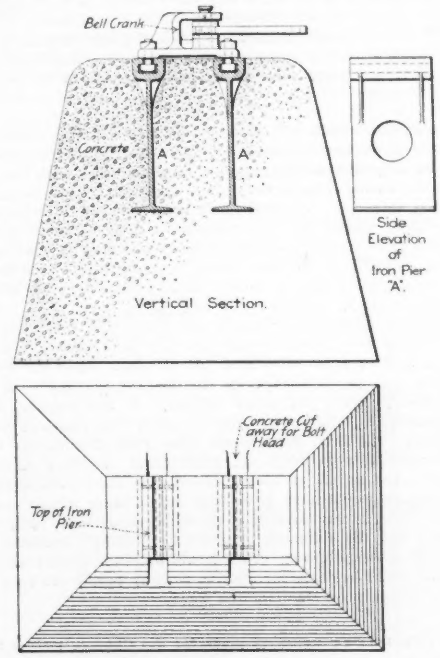

Fig. 1.—Iron and Concrete Foundation in Signal Work. National Switch and Signal Co , Makers.

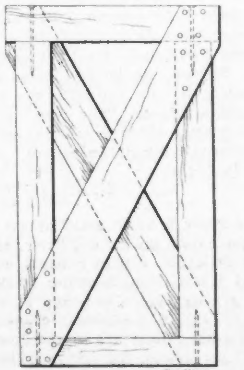

Fig. 2.—Improved Wooden Foundation for Signal Work.

Where it is necessary to use timber foundations, the company employs the style of frame shown in Fig. 2, which is considered much better and more durable than the ordinary style of frame in which the parts are dovetailed together, for the reason that shrinkage and decay occur at the dovetailed joints. The foundation shown in Fig. 2 is that used by the company at the extensive interlocking plant at State Line, Ind., which plant we shall describe in a later issue. A general objection made against combination wood and concrete foundations is that, in consequence of the distrubance of the earth in excavating for the foundations, the concrete (which only surrounds the head of the wooden frame) is found to settle and thus break away from the frame. This has occurred to such an extent as to lead to the designing of the solid and permanent type of foundation shown in Fig. 1.

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A WATER POWER PROJECT at Anaconda, Mont., is being instituted by the Anaconda Copper Mining Co., and it is expected to develop about 15,000 HP. There are now two reservoirs, one of 750,000,000 gallons and one of 75,000,000 gallons, and surveys are now being made for a system of reservoirs to impound water from mountain streams. Mr. Chester B. Davis, M. Am. Soc. C. E., is Chief Engineer, and Mr. C. W. McMeekin, M. Am. Soc. C. E., has been appointed as his assistant in charge of the work.

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THE MENOMINEE RIVER WATER POWER project is said to have been successfully financed, and a contract has been let to C. B. Pride, of Appleton, Wis., for the dam at the Chapple Rapids, which is to be built this winter. The dam will be seven miles from Marinette, Wis., and the electric current from the power plant will be conveyed to that city and to Menominee to supply the street railways, the paper factories, etc. The cost of the plant is estimated at $150,000. The work will be done for the Marinette & Menominee Electrical Co., which has a capital stock of $200,000. John Spalding, of Chicago, Ill.; Fred Carney, of Marinette, Wis., and S. M. Stephenson, of Menominee, Mich., are among the incorporators.

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AN 8-MILE ELECTRIC TRANSMISSION plant was recently put into operation in Wisconsin between the towns of Somerset and New Richmond. The power for operating the 250-K-W. three-phase Westinghouse generator is obtained from the Apple River, at Somerset, where a dam and tailrace were constructed, which gave a working head of 17 ft. Two 42-in. turbines built by the Dayton Globe Iron Works, of Dayton O., were installed. To protect the tailrace from high water a breakwater dam was constructed for about 500 ft. down stream. For about one-third of its length it is 12 ft. wide on top, the remainder narrowing to 8 ft. From the bottom of the stream to the water surface the dam is built of white pine log cribs filled with bowlders. Above this squared timbers and quarried rock form the body of the dam. The generator, which weighs 25 tons, furnishes current to the lines at 6,000 volts, at which pressure it is transmitted over three No. 5 B. & S. hard drawn copper wires. The poles used average about 25 ft. long by 7 in. in diameter at the top. Imperial No. 2 insulators, guaranteed to stand a pressure of 40,000 volts, are mounted on substantial pins and cross arms. At the receiving end the three-phase current is transformed down to a two-phase current at 200 volts. This drives a 100 HP. induction motor operating a 400-bbl. flour mill, a 30 HP. motor operating a pump supplying the waterworks, a 20 HP. motor driving a 30-light T. & H. arc light machine, one 15 and one 50 HP. motor, each operating elevators. The current also feeds a number of street lamps.

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A STORAGE BATTERY, said to be the largest ever made, is being built by the Electric Storage Battery Co., of Philadelphia, Pa., for the Chicago Edison Co., at a cost of $100,000. It will have 166 cells and will weigh nearly 500 tons.

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THE WILL OF ALFRED NOBEL, of nitroglycerene fame, has been proved. Mr. Noble died at San Remo, Italy, on Dec. 9, 1896. His personal estate is valued at $2,170,465. About half the estate goes to relatives. The interest on the invested remainder is to be annually divided into five prizes of $10,000 each. Of these, prizes 1, 2 and 3 are to be awarded to persons making the most important discoveries in physics, chemistry, physiology, or medicine. The fourth prize is for the best literary composition on the subjects of physiology or medicine; the fifth will go to the person who has achieved the most in the direction of promoting peace throughout the world. The prizes are open to competitors of all nations and will be awarded by the several Swedish Academies; except the fifth, which will be in the hands of a committee elected by the Norwegian Parliament.

PREMIUMS FOR DOMESTIC ARCHITECTURE, after Jan. 1, 1898, will be annually awarded by order of the Municipal Council of Paris. This award is open to architects and to the proprietors of houses built during the year. The proprietors of the six best houses, from an architectural standpoint, will be exempt from the regular tax on new construction; and to each of the architects designing these six houses a premium of 1,000 francs, or $200, will be paid. The jury of award is to be made up of five members of the Municipal Council, the Director of Architectural Work of the City of Paris, the Inspecting Architect of the District and two architects selected by the competitors.

A NEW BUILDING CODE for the City of New York is under consideration by delegates from a number of trade associations supposed to be interested. A meeting was held at the rooms of the Builders' League, 24 East 125th St., on Dec. 30, to take steps toward making a united appeal to the Municipal Assembly for the enactment of a new code. Mr. William P. Fryer was chairman of the meeting and Mr. Albert E. Davis secretary. Delegates were present from the Builders' League, Society of Architectural Iron Manufacturers, United Building Trades, North Side Board of Trade, and Mechanics and Traders' Exchange. Another meeting is to be held Thursday, Jan. 13, at 8.15 p. m. According to a report in the daily press:

> Among the other organizations invited to send delegates, most of which have responded favorably, are the New York Chapter American Institute of Architects, the Architectural League, the Board of Fire Underwriters, the Fire Department, the Mason Builders' Association, the Real Estate Owners' and Builders' Association, the Real Estate Exchange and Auction Rooms, Limited, and the Association of Master Plumbers.

It is to be noted that in this long list of societies which are invited to send delegates to the meeting the American Societies of Civil Engineers, Mechanical Engineers, Electrical Engineers and Heating and Ventilating Engineers are not mentioned. It would seem that these are the very societies that should be consulted in regard to the preparation of a new building code.

THE OLD NEW YORK AQUEDUCT COMMISSION, removed by the administration, has decided to contest their removal as illegal. The commissioners claim that the laws of 1888 provide that the Aqueduct Commissioners may be removed for cause; but that they shall not be removed without being heard in their own defence. They were not even given the option of resigning by the new Mayor.

WATER RATES AT BUFFALO have been lowered by the passage of an ordinance amending Chapter XXXII. of the City Ordinances, relating to water-works. The rates for dwellings are based partly on the frontage and number of stories of the structure and partly on the number of fixtures used. One rate covers all sinks, wash bowls and laundry tubs in a house, ranging from $2.50 a year for a 1-story house with less than a 25 ft. front to $9 for a 5-story house with a front of from 45 to 50 ft. For a 3-story house with a frontage of from 25 to 30 ft. the rate for the above purposes is $5.50. Bath tubs, with shower baths if desired, are supplied at $1 per year, and self-closing water-closets at $1.50. The meter rates are fixed at 6 cts. per 1,000 gallons for all quantities below 22,500 gallons per month and 2 cts. for all above that amount, but no meter will be furnished for any purpose unless the annual amount per meter is $24 or more. In order to make these low rates possible the ordinance provides for the raising by taxation of $20 per fire hydrant per annum for water used for fire purposes, the amount so used to be credited to the water fund and charged to the fire fund. Other city departments are to pay 2 cts. per 1,000 gallons for all water used by them. In our issue of Dec. 2, 1897, we commented editorially on the then proposed reduction in water rates and briefly discussed the proper division of the cost of city water supplies between public and private consumers.

THE ELBE-TRAVE CANAL, which is to follow the general line of the 500-year-old Steecknitz Canal, will connect Lubeck with Lauenberg on the Elbe. The old canal was 60 miles long, with 17 locks; the highest being 40 ft. above the level of the Elbe. Its average breadth was only 40 ft., with a couple of feet depth of water. The new canal will be straighter, and shorter by about 20 miles; it will have a bottom width of 70 ft. and a top width of about 100 ft., with 6½ ft. depth, or deeper if the river is deepened. The locks will be reduced to seven in number, and their maximum dimensions will be 250 ft. long, 35 ft. wide, 7 ft. deep, admitting vessels of about 800 tons. The estimated cost of the new canal is $6,750,000, of which sum the City of Lubeck will provide about $5,000,000, and the Prussian government the remainder.

THE OHIO STATE CANAL SYSTEM, and what is to be done with it, is one of the most important questions before the Ohio legislature. The canals of the state are over 600 miles in extent, and cost originally $14,340,000. The sum of $10,924,000 has been expended on their repair and maintenance. This makes the total cost $25,264,000, and the receipts from tolls, etc., have amounted to $16,340,000. The canals have deteriorated in recent years and the traffic has fallen off to a trifling amount on the Ohio canal last year, the tolls amounted to $24,000, and the expenses of operation were $78,000. The canal system was recently investigated by a commission appointed by the Governor, but it recommended simply that the state decide upon a definite policy and either improve the canals or else entirely abandon them. It favored, however, the former course. On the other hand, the farmers of the state generally favor the abandonment of the canals; large tracts of land are injured by the seepage from reservoirs, etc., and the maintenance of bridges and repair of damage done by the canal waters in times of flood form quite a large item of expense.

THE BILL FOR THE PROTECTION OF THE MISSISsippi Valley, introduced into Congress by Gen. Catchings, of Mississippi, makes the Mississippi River a national care and provides that the government shall acquire ownership and control of all state and other levees; and puts these in charge of the Mississippi River Commission, under the direct supervision of the Chief of Engineers, U. S. A. Congress is also asked to appropriate $20,000,000 for this work, not more than $5,000,000 to be expended in any one year.

GRAIN FREE ON BOARD AT NEW YORK ELEVAtors is demanded from the railway companies by some of the largest Western shippers of grain from the port of New York. The railway men understand this to mean that they must transfer grain from cars to the steamers without charge, as it is claimed is done at other ports. The Erie elevator is said to be performing this service, in connection with canal boats, in competition with floating elevators, but it makes some charge for the same. This rivalry, however, can only exist, says "The Commercial Advertiser," during an active and large movement of grain, when regular line steamers cannot load at the railway grain elevators. At all other times the business will be controlled by the floating elevators, as in ordinary years the grain capacity of the regular line steamers is sufficient to move the grain that comes to New York. The Erie, West Shore, New York Central and the Pennsylvania railways all have grain elevators at this port; but at all of these, except the Erie, considerable dredging would have to be done before large vessels could use them. If the demands of the shippers are to be complied with and the shipment of grain by "tramp" steamers is to be developed, very considerable building of new elevators would be required; and the railway people are said to be seriously considering this work.

THE GREAT LENSES made for the Chicago Exposition by Henry Lepaute, of France, and purchased by the U. S. Lighthouse Board for $10,000, are being tested at Tompkinsville, Staten Island. These lenses are 9 ft. in diameter, and each is made up of a central disk, two prismatic rims and 190 prismatic segments of rims, all made of carefully ground optical glass. The prisms of each lens are mounted in a brass framework, made in 19 sections. The three lamps are of a specially designed arc type, with two of them interchangeable by simply turning a wheel, and the third can easily be substituted for either of the other two. With 1-in. carbons the light equals from 8,000 to 10,000 c. p. Each lens gathers nearly half of this light and projects it in a beam 9 ft. in diameter, which has an estimated intensity of 90,000,000 c. p. On a sufficiently elevated lighthouse this light could be seen 100 miles away. Though the lamps, lenses and supporting framework weigh 20 tons, the light can be made to revolve six times a minute. The plant will include two General Electric alternating generators, operated by a 25-HP. Ideal engine and Fitzgibbon boilers. All parts of the plant are in duplicate.

BIDS FOR A NEW WATER SUPPLY for Jersey City, or for filtering water from the Passaic River, at the old pumping station in Belleville, will be received until Feb. 23, by the Street and Water Commissioners. Bids may be submitted for a gravity supply delivered at an elevation of either 210 or 127 ft. The estimated quantity of water required is 20,000,000 gallons a year the first year, with an increase of 3% per annum thereafter. The main features of the specifications were outlined in our issue of Sept. 30, 1897. Messrs. C. C. Vermeule, of 203 Broadway, New York city, and Garwood Ferris, of Jersey City, are consulting engineers for the proposed new supply.

ANNUAL MEETING OF THE AMERICAN SOCIETY OF NAVAL ENGINEERS.

The annual meeting of the American Society of Naval Engineers was held in Washington, D. C., on Jan. 7 and 8. This society has been in existence for several years, its chief business being the collection and publication in its "Journal" of professional papers on naval subjects, but it has not heretofore held open meetings for the presentation and discussion of papers according to the usual custom of engineering societies. It has now taken a new departure and has held a convention in the usual fashion, with the common accompaniments of excursions to points of interest and a banquet.

The first session was held at the Columbian University, on Friday afternoon, Jan. 7. About 50 members and associates were present, many of the former being engineers in the U. S. Navy. After the reading of the report of the Council it was announced that the winner of the prize medal, which is yearly awarded for the most meritorious paper, was Past Asst. Engr. W. W. White. His paper was entitled "Steam Consumption of the Main and Auxiliary Machinery of the U. S. Steamship "Minneapolis." We shall publish an abstract of this paper at an early date. The paper was printed in advance of the meeting, and proofs were in the hands of the members. The other papers had not been printed. In this matter the society may well take a lesson from the practice of other engineering societies. After the presentation of the paper by its author it was discussed by several of the members. Mr. F. Merriam Wheeler, of New York, discussed at some length the auxiliary machinery and its wasteful steam consumption, and pointed out that the greater part of the heat wasted by this machinery on war vessels could be saved by the use of a feed water heater into which all the exhaust steam from the auxiliary engines should be discharged. The next paper read was entitled "American Steam Yachts," by Mr. Irving Cox, of New York. He expressed the opinion that the reason why many Americans go abroad to purchase yachts is because American-built yachts have been defective in many details of their construction and consequently unsatisfactory to their owners. When the paper is printed it will probably be answered by some of the American yacht builders, and if the author's criticisms are just, it may lead to an improvement in the method of the builders. The paper gives some figures of the cost of running a steam yacht which will be of interest to those of our readers who expect to become yacht owners. For a first-class cruiser, entertaining ten guests, the cost of maintenance is from $3,600 to $4,000 per month.

Two papers on water-tube boilers were then presented and discussed together. The first was "Test of the Niclausse Safety Water-Tube Boiler," by J. M. Whitham, of Philadelphia, and the second was "Water-Tube Boilers," by Darwin Almy, of Providence, R. I. A long discussion followed, emphasizing the general opinion that water-tube boilers are likely in time to supplant the old forms of boiler, which have reached their limit of weight and size.

The last paper of the session was by Mr. David P. Jones, on the subject of "Boiler Testing, with Various Fuels." Mr. Jones has made a specialty for the past few years of testing boilers with Western fuels, and his paper contained much information of interest. The discussion was postponed till the next day.

In the evening a business session was held in the Navy Department, in the rooms of the Chief of the Bureau of Steam Engineering. The treasurer's report showed a satisfactory financial condition for the society. Officers for the ensuing year were elected as follows: President, Chief Engineer Harry Webster, U. S. N.; Secretary-Treasurer, Past Asst. Engr. Walter M. McFarland, U. S. N.; Members of the Council, Chief Engineer T. W. Baird, U. S. N.; Passed Asst. Engr. W. W. White, U. S. N.; and Passed Asst. Engr. E. Theiss, U. S. N.

Saturday morning was spent in sight-seeing, visits to the navy yard and to the Congressional library. In the afternoon a second professional session was held in Columbian University. After a discussion of Mr. Jones' paper on "Boiler Testing," a paper on "Speed of Construction, a Vital Factor in Naval Strength," was read by Mr. Frank B. King, of Washington. It was followed by a paper by Col. E. D. Meier, of St. Louis, on "The Diesel Motor." This motor is an improved oil engine, invented by a German mechanic, which is soon to be manufactured in this country. It is claimed to have a higher efficiency than any other heat engine, whether steam, gas or oil.

"Oil Fuel Trials on the Hydraulic Life Boat 'Queen,'" by John Platt, of New York, was the last paper read. The paper describes a life boat propelled by jet propulsion. We shall publish this paper in an early issue. Other papers were read by title and will be published in the "Journal." In the evening a banquet was held at the Maison Rauscher. Mr. John C. Kafer, of New York, was toastmaster. It was a highly successful and enjoyable affair, and some of the speeches, made by old naval engineers, describing how things were done in the old navy, with steam pressures of 10 lbs., were of unusual interest.

The following are the titles of the papers which were "read by title:" "The Submarine Boat 'Plunger,'" by J. Alvah Scott, of Baltimore; "Entropy and Temperature Entropy Diagrams," by Prof. W. F. Durand, of Ithaca, N. Y.; "The Status of Boards on Changes as Usually Constituted Under the Contracts for the Construction of Our New Navy," by W. W. Varney, of Baltimore; "Propulsive Power," by James N. Warrington, of Chicago.