ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

Vol. XXXIX., No. 9.

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NUMEROUS BIDS FOR A NEW WATER SUPPLY for Jersey City were received on Feb. 23 from five different parties, but all the proposals of two of the contractors and three out of five submitted by another were informal. The bid of the Pennsylvania Sanitation Co., of Philadelphia, was not accompanied by the required check and that of the Geo. B. Inman Contracting Co. failed to comply with the specifications by omitting certain data and drawings. There remain eight propositions, submitted by three companies, as follows: The Rockaway & Hudson Co., of Jersey City, two proposals, for water from the Rockaway River; Patrick H. Flynn, of Brooklyn, three, for water from the Rockaway; O'Brien, Sheehan, McBean & Rogers, 258 Broadway, New York city, three, from the Raritan River or from the Rockaway River. On the face of the bids the lowest proposition was from the Rockaway & Hudson Co., which offers to deliver water at 210 ft. above tide at the following prices per million gallons: Up to 20,000,000 gallons, $33; then $30, $25, $20 and $16, respectively, for each million of each succeeding 5,000,000 gallons; an average of $22.30 per 1,000,000 gallons when the full amount of 50,000,000 gallons is delivered. The same bid includes the privilege of purchase of the works by the city for $6,000,000 within one year from the date of the contract, or $6,150,000 at the expiration of 5, 10 or 15 years, the daily capacity of the works to be 50,000,000 gallons. The propositions are now being examined in detail by Messrs. C. C. Vermeule, 203 Broadway, New York city, and Garwood Ferris, of Jersey City, engineers, respectively, for the Finance and Street and Water Boards.

ESTIMATES FOR A MUNICIPAL WATER-WORKS plant at Des Moines, Ia., have been submitted to the city council by Mr. L. Higgins, City Engineer. The estimated cost of complete works is $1,472,000. This includes a supply of 16,000,000 gallons per day from infiltration galleries near the Des Moines River with a capacity of 75 gallons per sq. ft. It is expected that the original yield of the galleries would be at least double the above rate. A large stand-pipe is proposed. The city is now supplied by a private company, between which and the city there has been almost continuous litigation for years.

THE CONSOLIDATION OF TWO MECHANICAL FILter companies after several years of bitter conflict, as noted from time to time in this journal, has been effected as set forth in the following official statement:

> Within the past few days, and as the result of the long and successful litigation of the New York Filter Manufacturing Co. against the Jewell filter, the O. H. Jewell Filter Co., of Chicago, Ill., has made settlement for its past infringements and taken a license under the Hyatt patent, by the terms of which it becomes the exclusive licensee under the Hyatt patent for all territory west of Pennsylvania, north of the Ohio River and west of the Mississippi River, including Tennessee and Kentucky. Hereafter the New York Filter Manufacturing Co. will confine its business to the eastern territory, and within that territory will supply the Jewell filter. The Morison-Jewell Filtration Co., of New York and Philadelphia, has likewise made a settlement, and is to retire from business. The New York Filter Manufacturing Co. has elected as its President, Mr. W. G. Warden, of Philadelphia, and as General Manager, Mr. Samuel L. Morison, heretofore Vice-President and General Manager of the Morison-Jewell Filtration Co. The offices of the company will continue for the present to be located at 120 Liberty St., New York city.

In the same connection it may be noted that the Loomis filter, manufactured by the Loomis-Manning Filter Co., of Philadelphia, has been declared to be an infringement on the Hyatt patent, in so far as the use of alum is concerned. This declaration was made on Feb. 26, in connection with a preliminary injunction granted by Judge Lacombe of the United States Circuit Court for the Southern District of New York.

THE LIGHTING OF THE CITY OF BUFFALO by electricity transmitted from Niagara Falls will be accomplished within about six months, if the present plan can be carried out. Extra cables will be run from the large power plant of the Niagara Falls Power Co. to Buffalo, a distance of 26 miles, on the pole line now used by the Buffalo Railway Co. (Eng. News, Dec. 10, 1896). In the Buffalo transmitting station will be installed eleven 250 K-W. air blast transformers wound for 11,000 or 22,000 volts primary and 352 volts secondary, several 400 K-W. frequency changers, 30 No. 12 125-light Brush arc machines and 15 250-HP. synchronous motors, each of which will drive two Brush machines. Two 200-HP. 500 volt rotary converters will supply the direct current power circuits. The entire electrical contract, which also includes all necessary auxiliary apparatus, was awarded to the General Electric Co., Schenectady, N. Y.

THE LIGHTING OF THE OMAHA OR TRANS-MISSissippi Exposition will, according to the plans of Mr. Luther Stieringer, the consulting engineer, fully equal the magnificent effects of the World's Fair, for which he was also lighting expert. Already about 2,155 K-W. in dynamos and transformers have been ordered for illuminating purposes. This total includes four Bush arc light generators of the multi-circuit type, of 125 lamps capacity each; four 120 K-W. and two 180 K-W. high frequency alternating current generators for 1,040-volt circuits, and 840 K-W. of transformers of different sizes; 600 double or single carbon arc lamps of 2,000 c. p. will be employed about the buildings and grounds. A power circuit, supplied from a 225 K-W. 550-volt generator, is also included in the contract, as well as the necessary exciters, switchboards and all needed auxiliary apparatus. The contract was awarded to the General Electric Co., of Schenectady, N. Y.

CARS LIT WITH ACETYLENE GAS have been running for several weeks on the Pontiac Pacific Junction Ry., from Ottawa to Waltham, Ont. Mr. P. W. Resseman, General Superintendent of the Company, writes us, under date of Feb. 22:

> The test of calcium carbide acetylene gas for lighting our passenger trains for the past month has been most satisfactory. Under the old system of oil lighting our coaches with the 14-light chandeliers, gave a poor light; under the acetylene gas system we use but five lights in the body of the coach, and with most satisfactory results, being a far better light than electricity or any gas light now used in coaches in the United States or Canada. I believe we are the first railway to inaugurate this system. The cost after the installation is cheaper than under the old system. At present the generator for the full train is located in our baggage car and piped to the different coaches, but it is our intention to install each car with a small generator of its own, which will do away with piping connections between the cars.

ACETYLENE AND OIL-GAS FOR TRAIN LIGHTING is being introduced on the state railways of Prussia, after a series of tests. The mixture used is one part acetylene to three parts of oil gas; the illuminating power of the latter being thus increased 300%. A flame consuming 27 litres of the mixture per hour produces a 16-c. p. light. No change is required in the present manufacturing methods or in the oil gas appliances. As a model for the installation at other points the new method will be first applied at the Grunewald Station, near Berlin, where, at 10 hours per day, the minimum annual consumption is 21,180,000 cu. ft. of gas. At the present time 127,000,000 cu. ft. of Pintsch oil gas is annually consumed on the Prussian railways. On this basis 31,800,000 cu. ft. of acetylene gas will be required per year, requiring for its production 3,000 tons of calcium carbide.

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on the Savannah, Florida & Western Ry., Feb. 25, one mile beyond Braganza, Ga., and resulted in the death of one person and the slight injury of seven others. Reports state that a trestle was burning and a heated rail flew up, catching in the forward truck of the dining car. Three Pullman cars went through the trestle and in a few minutes were on fire.

AN EXPLOSION IN A CHEMICAL WORKS at Kalamazoo, Mich., resulting from a fire, blew the roof off the building and hurled a number of firemen and spectators under the ruins. It is reported that two firemen and six men were killed, while 10 persons were injured.

THE STEAMER "CHAMPAGNE," of the French Line, which sailed from Havre on Feb. 12 for New York, broke her propeller shaft on Feb. 17 and was compelled to anchor in 40 fathoms about 150 miles off the banks in a dense fog. On Feb. 19 she broke her anchor chains in a fierce gale and drifted southwest until Feb. 23, when she was taken in tow by the "Roman," of the Warren Line, and brought into Halifax on Feb. 27. The "Champagne" will be dry-docked at Halifax for repairs. The third officer of the "Champagne" and a volunteer crew covered 465 miles in a small boat, in seven days, in the attempt to seek for aid, and were finally picked up by the "Rotterdam," of the Holland-American Line.

THE STATE ST. BRIDGE, in Chicago, is reported as in a dangerous condition by City Engineer Ericcson. The foundations for this bridge over the Chicago River were put in soon after the great fire, when the depth of the river was only 12 ft. The channel has since been dredged to 17 ft., and under the late heavy trolley-cars traffic the center pier has settled 4 ins., and the abutments are also settling. The Commissioner of Public Works lately asked for $175,000 for the construction of a bascule bridge at this point, but he failed to get the money. The Chicago authorities have lately ordered that all bridges across the river shall have the draws operated by electricity. The average cost of making the change is estimated at $1,000 for each bridge.

THE PROPOSED NIAGARA RIVER BRIDGE, to Grand Island, cannot be successfully opposed as a possible serious obstruction in a navigable stream. Major T. W. Symonds, Engineer Corps, U. S. A., and in charge of government improvements at Buffalo, N. Y., points out that this river cannot be classed with the Detroit, St. Clair or St. Mary rivers as a through channel of commerce. It is simply a part of the great harbor at the lower end of Lake Erie; and should be commercially ranked with the Chicago, Cuyahoga and Buffalo rivers, all parts of lake harbors over which bridges are a necessity. The Buffalo "Commercial," in combatting the project, admits that this is true; but it advises the city of Buffalo to fight shy of the men engaged in promoting the project. These men are termed "charter-mongers"; and are said to be the same men who secured at Albany the Queen City Gas Co.'s blanket franchise for a gas supply to Buffalo, and then sold the charter instead of making gas.

A BASCULE BRIDGE ACROSS THE CLYDE, at Glasgow, is proposed by Mr. C. C. Lindsay, to meet a demand for a means of crossing this river about one mile westward of the present bridge. Mr. Lindsay has made a report to the Corporation on three alternative plans. One is for a semi-high-level bridge, with a bascule span of 120 ft. giving 107 ft. of waterway, and two side spans of 241 ft. and 249 ft., respectively. The north approach would be 1,143 ft. long, and the south 669 ft. long, to minimize grades. The headway secured would be about 30 ft. at high tide; and only about 32 vessels in 24 hours would require more than this. The bridge would be 66 ft. wide on the floor, reduced to 55 ft. at the bascule, and the ruling gradient would be 1 in 29. The estimated cost is $1,000,000; or, about $450,000 more than the cost of a bridge at the level of the quay. Another bascule plan, with arches giving a headway of 14 ft., is estimated to cost $545,000. This last would require the bascule to be opened for 46 vessels in 24 hours; but would have a grade of only 1 in 40. The alternate schemes are under consideration.

A RAILWAY BRIDGE OVER THE RED RIVER, at Hanoi, Tonkin, is to be built by Dayde & Pille, the French contractors now constructing the bridge of Alexander III., over the Seine, in Paris. This bridge will be used in connection with the first railway constructed in Tonkin, and intended to connect Hanoi with China, by way of Langson. As briefly described in "Le Genie Civil," the bridge will have a total length, between abutments of 5,838 ft., divided into spans of 246 ft. with one span of 348 ft. These spans will be supported on masonry piers resting upon metallic caissons sunk to a depth of about 98 ft. below the water by the pneumatic process. The height of the piers above the water level will be 38.7 ft. About 5,000 metric tons of steel will be required, and the estimated cost is $1,000,000.

THE BROOKLYN ELECTRIC SURFACE CARS are now running at intervals of 15 seconds across the Brooklyn Bridge during rush hours, and are carrying about one-third of the traffic across the structure. The fact that no extra charge is made on these cars is sufficient to make the public crowd them to their capacity rather than pay the bridge fare of 2½ cts. The relief from crowding on the regular bridge trains is very noticeable. It appears extremely probable that as soon as the elevated railway lines are running across the bridge the separate bridge trains can be abandoned entirely, without detriment to the public, and with a large saving in the operating expenses.

ELECTRICITY ON MEXICAN STREET RAILWAYS is proposed by the syndicate operating the 140 miles of road. Electric motors are spoken of, and the estimated cost of the new service is about $5,000,000. When plans are fully prepared public announcement will be made to all electrical manufacturers, says the "Bulletin" of the Bureau of American Republics for February.

ARTESIAN WATER SUPPLY OF GALVESTON, TEX.

By R. H. Peek.*

The present water supply system for Galveston was begun Sept. 12, 1894, and completed and turned over to the city for operation on August 19, 1895, the contractor's guarantee of six months expiring on February 19, 1896. The original plans and specifications were prepared by Mr. W. Kiersted, M. Am. Soc. C. E., of Kansas City, Mo. The contract was awarded to J. W. Byrnes & Co., of Galveston, and executed May 27, 1893. Delay in placing the water-works bonds put off the commencement of the work for some time.

Various surveys and examinations were made previous to the selection by the board of the present site for the supply. Eighteen months, the time for which Mr. Kiersted's services were secured, having expired, he resigned, and Mr. H. T. Wilson, late City Engineer of Galveston, was elected Engineer in Charge of Construction. The original plans and specifications were changed and very much simplified, in order to eliminate every thing that was not deemed absolutely necessary. The contract price to complete the whole work, according to Mr. Kiersted's plans and specifications, was $779,992, but the plans only included the sinking of six wells. The additional cost to sink the required number of wells, and connect up the same, furnish and lay the influent pipe, was very nearly saved by changes and eliminations in the original plans, which were not deemed hurtful to the efficiency of the system, so that the whole work was completed for $790,000.

The work was prosecuted by Mr. Wilson until May 31, 1895, with the writer as assistant, when Mr. Wilson retired, and I was elected by the board Engineer in Charge, and completed the construction. Afterwards I was elected Superintendent of the works, which position I at present hold.

The system consists of 30 artesian wells, 27 being 7 ins. and three being 9 ins. in diameter, connected by an influent pipe directly with the 30-in. conduit to the receiving tank at the pumping station in the city. The location of the wells and conduit, and a profile of the latter are shown by Fig. 1.

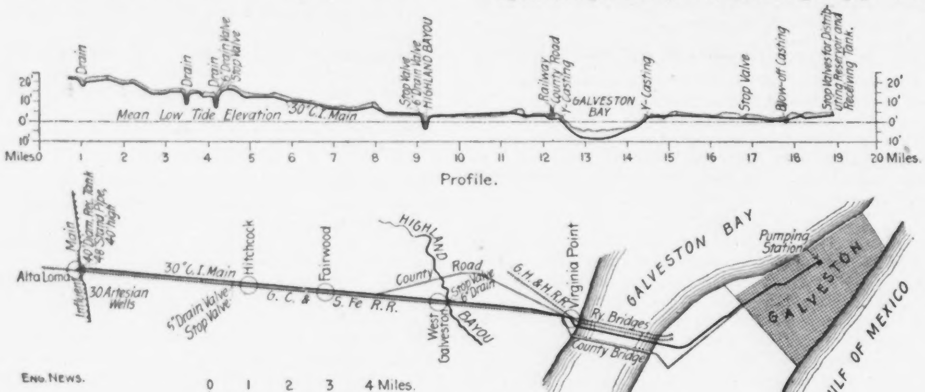


FIG. 1.—PROFILE AND PLAN SHOWING CONDUIT AND ARTESIAN WELLS FOR THE WATER SUPPLY OF GALVESTON, TEX.

The contract for pipe-laying was sublet to McRitchie & Nichols, of Chicago. They superintended in person, and laid the submerged pipe under Galveston Bay. The pipe on the mainland and island was laid by B. F. Rounds, of Chattanooga, Tenn. The wells were bored and the influent pipe laid at Alto Loma by J. W. Byrnes & Co., superintended by Mr. L. V. Elder.

Upon completion of the submerged pipe under Galveston Bay, 10,352 ft. in length, and the setting of the two 30-in. valves, one on each shore of the bay, the pipe was tested to a pressure of 100 lbs. per sq. in.

Upon the completion of the entire conduit from the supply to the pumping station, about 18½ miles, it was tested throughout its entire length to a pressure of 80 lbs. per sq. in. This test was begun on Aug. 7, and completed on Aug. 17, 1895. On the first day a 40-lb. pressure blew out the temporary plug in the stand-pipe casting, and started a few leaks along the line at the lead joints. The plug was replaced and on the 8th pressure was carried to 80 lbs., when a pipe burst in the city. This broken pipe was replaced by a new one, all leaking joints recalked, and the pressure put on again to 85 lbs., and every leak repaired and made tight under pressure. Two pipes were found to be cracked, and were repaired by cast-iron split sleeves, about 20 ins. deep. During this time there developed eight more cracked pipes, which were repaired by cast-iron split sleeves, similar to those previously mentioned. These cracks occurred about the middle of the pipes in every instance, and were almost exactly perpendicular to the axis of the pipes throughout the whole length of the cracks. The pipes were laid sometimes on a uniform clay foundation on the mainland, and sometimes on a sand foundation on the island, in a trench, from 1½ to 4 ft. deep, carefully brought to a uniform grade in the bottom. The pipe and special castings were furnished in equal quantities by the Chattanooga Foundry & Pipe Works, of Chattanooga and Bridgeport, Tenn., and the Howard-Harrison Iron Works, of Bessemer, Ala.

The conduit empties into a receiving tank 40 ft. in diameter by 12 ft. deep, the bottom 4 ft. below its discharge end. The estimate of the flow into this tank was made as follows: The water is lifted from the tank into the distributing reservoir, 100 ft. in diameter by 20 ft. deep, by a 5,000,000-gallon pump. The water in the tank was kept down by this pump for eight hours, when the pump was stopped, and the tank allowed to fill to the top, or rise 10 ft., equivalent to 94,245 gallons, taking 30¼ minutes, showing a delivery of 4,500,000 gallons per 24 hours.

The flow into the suction well or receiving reservoir at Alta Loma was determined in a similar manner. The discharge there was so rapid, and the receiving reservoir so small, that only an approximate estimate was arrived at. The discharge ends of the influent pipe into the reservoir were plugged, so that the plugs could be pulled by blocks and ropes arranged for the purpose. The water was allowed to flow into the conduit on to the city for six hours, to get as nearly as possible the normal flow of the influent from the wells. The 30-in. valve in the conduit was then closed, taking about nine minutes, and the plugs pulled. The discharge was estimated at from 9,000,000 to 12,000,000 gallons per 24 hours, filling the tank at the rate of 1 ft. in 1¼ minutes. The contractor's guarantee was for a delivery into the receiving reservoir at the elevation of the influent, of 5,000,000 gallons per 24 hours.

The conduit will be connected with the distributing tank, and the 5,000,000-gallon lift pump abandoned. The distributing tank has a capacity of 1,175,000 gallons, so that in the event of repairs being required on the conduit, 12 or 14 hours' supply can be put into it for the city, thus affording time to make any ordinary repairs, without cutting off the city's supply.

As there was so little deviation from a uniform grade in the conduit from Alta Loma to Galveston, the 6-in. air valves originally designed were abandoned, and a few summits were tapped with ¾-in. pipes affording water for watering troughs and air escapes also.

The wells, 30 in number, were located in a line north and south, and from 300 to 750 ft. apart, the distance between the extreme wells being 16,350 ft.; 16 wells are on the north side and 14 on the south side of the receiving reservoir. They were put down by the rotary hydraulic process, with standard drive pipe, manufactured at McKeesport, Pa. They are 7 and 9 ins. in diameter, 750 to 850 ft. in depth, furnished with strainers from 20 to 35 ft. in length, depending upon the thickness of the water bearing sand strata. They were capped on a level with the influent pipe with a 7×7×8-in. tee for the 7-in. wells and a 9×9×8-in. tee for the 9-in. wells, connected into the influent pipe, which was laid alongside and within 5 ft. of the wells by a special Y casting. An 8-in. gate valve, flanged on one end and with a hub on the other, was bolted onto the flanged tee, and received the 8-in. pipe connecting with the special Y casting. Each well top and its 8-in. valve is encased in a brick well built up to the surface of the ground and

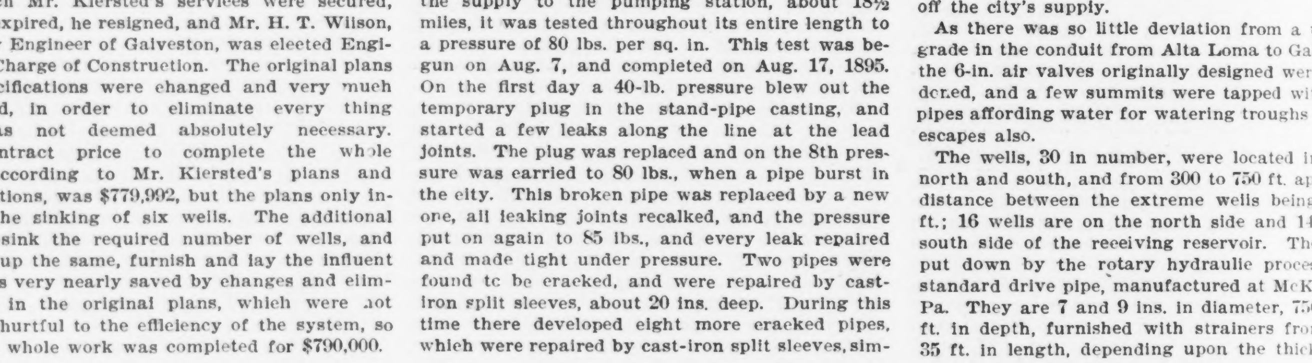


FIG. 2.—LAYING 30-IN. CAST-IRON SUBMERGED MAIN ACROSS GALVESTON BAY, TEX.

*Superintendent of Water-Works, Galveston, Tex.

furnished with a cast-iron cover. The wells, at 2 ft. above the surface of the ground, showed a static pressure of from 5 to 7 lbs. per sq. in.

The influent pipe was laid to an average depth below the surface of the ground of about 9 ft., commencing at the extreme wells with a diameter of 14 ins., and increasing successively to 16, 18, 20, 24 and 30 ins. The influent pipe from each direction meets in a special 36x36x36-in. tee, connected with the supply conduit by a 36 to 30-in. reducer. Connection was made into the receiving reservoir about 11 ft. below the surface of the ground by two special 30-in. Y castings, and plugged. This receiving reservoir has been provided for use whenever it may become necessary to put a pump at the wells. For use in this connection a stand-pipe, 4 ft. in diameter and 40 ft. high, made from ⅜-in. steel plates, has been placed at the head of the 30-in. supply main leading to the city. When pumping is employed, the discharge from the pumps will enter the base of this pipe.

Along the line located for the submerged pipe across the bay soundings were taken every 100 ft., and a grade on firm clay foundation was established from 3 to 7 ft. below the bottom of the bay. Operations were begun from the western shore of the bay.

A pier was built out in the bay for putting the pipe together in sections. The water being so shallow a channel had to be dredged for some distance out, to allow the barge to come up to the pier. A small dredge was constructed for dredging out the trench to grade, and a barge was built provided with hoisting derricks, and a truss for carrying a section of pipe, as shown in the view, Fig. 2. A tram was built from the shore to the pier, over which the pipe was carried in a car to the pier. Eight lengths of pipe were put together on the pier, their joints poured with lead and securely calked. In this section of eight lengths, Pipe No. 1 had a special spigot with corrugations cast on the outside; Pipe No. 8 had a special bell turned out perfectly smooth on the inside to receive the special spigot of section No. 2, and so on.

For 100 to 150 ft. out into the shallow water wooden and earth dams were used to keep out the water, and the pipes were laid as on land, the last pipe out in the bay being one with a special bell to receive the special spigot and its lead collar of section No. 1.

A cast-iron form, the depth of the special bell, was made in two parts, so that when bolted around the special spigot it took the place of the special bell. It was made 1-16-in. less in diameter than the inside of the special bell, so that when taken off the lead collar would be small enough to slip into the special bell of the last pipe already submerged. Section No. 1, of eight lengths, was put together on the pier, the form or mold bolted around the special spigot and poured with lead, thus leaving a collar of lead sufficiently small to fit snugly into the submerged bell. The corrugations were cast on the spigot end (giving it somewhat the appearance of a screw, though the corrugations were not spiral but parallel), to prevent the lead collar from slipping off. The trench having been dredged on to grade, for this section the barge was moved alongside the pier, and eight chains, suspended from a truss, one to each pipe length, were attached. The section was slowly raised by the derricks (the open ends having been plugged up to exclude water), at the same time pipe were rolled out on skids on the opposite side of the barge as a counterbalancing weight. The section was then let down into the water until its buoyancy would nearly float it, the barge and section were then towed into the proper position and the sectoin carefully lowered, plugs having been knocked out, while a diver went down and guided the special spigot into the bell already submerged. The section was forced home by means of ropes and rigging from the barge. Each succeeding section was laid in the same manner.

The diver afterwards, while not engaged in entering a section, went down at each special joint, and calked it with tools specially designed for the purpose. The work of submerging progressed smoothly and with little or no interference, except occasionally from bad weather. The job was begun on Nov. 30, 1894, and completed on May 18, 1895. Upon the completion, and before the final hydrostatic test, the salt water was forced out and a pressure of 15 lbs. of air was put on to test for leaky joints. The few such joints found were stopped by the diver.

COUNTY SURVEYORS AND SURVEYORS-GENERAL.

By J. L. Van Ornum, Assoc. M. Am. Soc. C. E.

Very few of the states of the Union have civil engineering executive officers; and of those that have Surveyors-General or State Engineers, not all charge them with duties pertinent to the subject under consideration. Particularly illustrative of this statement is the fact that the Surveyors-General of Minnesota, instead of performing engineering duties, are simply scalers of logs and measurers of timber. The State Engineer and Surveyor of New York has duties mainly connected with the Erie canal; he must be a practical civil engineer, is elected for two years, and receives a salary of $5,000. The State Engineers of Colorado and Wyoming are executive officers for the control and development of irrigation; their term of office is two years, and the former receives $3,000 and the latter $2,500 per annum.

In Louisiana the surveyor of the parish of Orleans is ex officio Surveyor-General of the state. He must be a man of scientific attainments, with a thorough knowledge of the English, Spanish and French languages; he must execute bonds for faithful service for $6,000; he appoints deputies at his own expense; and he receives a salary of $600 in addition to the fees allowed the parish surveyors.

The Surveyor-General of Nevada makes certain surveys, and is officially "Chief Engineer and Commissioner of Internal Improvements." Among his duties (at least prescribed, if not all engrossing) is reporting to the Governor plans for the construction of roads, turnpikes, railroads, canals and aqueducts; he receives reports from county surveyors; railroads and toll-roads are required to file with him topographical maps of their roads and the adjacent country. He is elected for four years and his compensation is $1,000 per annum.

The only states that have thus far established any intimate and systematic relation between the county surveyors and the state engineer officer are California and South Dakota. In the latter state the Governor appoints, for a term of two years, the State Surveyor, who must be a practical civil engineer and surveyor with at least ten years' experience in his profession; he must execute bonds in the amount of $1,000, and his remuneration is $6 per day and expenses. He alone has power to examine candidates and grant licenses to practice land surveying, such persons being known as deputy state surveyors; county surveyors must be elected from among these licensed surveyors. The state surveyor shall issue instructions as to methods of making surveys in the state, transmitting them to the county surveyors and through them to the deputy state surveyors; and his successor shall be appointed from among the most efficient of these deputy surveyors. Like the old territorial officers of the same title, the Surveyor-General of California is still definitely charged with the care of its public lands. Similar to the provisions just given, California vests in the surveyor-general the duty of licensing land surveyors, but here it is upon examination by an examining board or on a proper certificate of recommendation signed by at least three licensed surveyors. The county surveyors must be chosen from among these licensed land surveyors. The salary of the surveyor-general is $6,000 per annum.

Coming now to the question of civil engineers for the counties, it may be said that Pennsylvania and Maryland form the northeastern limit of the states having such an officer. Some of these northeastern states provide for a county engineer (or establish a similar office) in certain cases, but they do not have an official county surveyor as such. In all the remainder of the United States, except South Carolina, the county surveyor is everywhere found.

In all but 4 of the 38 states and territories, having this system, the county surveyors are elected by vote of the county. In Alabama this officer is appointed by the county commissioners; in Virginia the appointment is made by the county judge; in Tennessee by the justices of the county court; and in Louisiana he is appointed by the governor and confirmed by the state senate. In all the 38 commonwealths there is one in each county, except in Alabama, which provides a double number. The county surveyors serve, of course, until their successors qualify. The specified term of office is three years in Alabama, Ohio and Pennsylvania; four years in Kentucky, Mississippi, Missouri, North Carolina, Oregon, Tennessee, Virginia and West Virginia; and two years in other states. The deputies are usually appointed by the county surveyors.

The requirement for the execution of a bond for "true and faithful performance of the several duties of county surveyor" is quite general. "Any person who may think himself injured by the neglect or misconduct of any county surveyor, or any of his deputies, may institute suit on the bond" (Kan). The amount of the bond varies from $500 to $10,000, the ruling figure being either one or two thousand dollars. The remuneration varies greatly. Some states fix a certain fee for each of the different specified services of the county surveyor; one state (Alabama) leaves the determination to the boards of county commissioners; while about half the states specify a per diem, varying from $2 in North Carolina to $10 in California, and averaging about $5 per day. One state (Montana) specifies an annual salary varying from $750 to $2,000, depending upon the class of the county.

It is surprising that in this day of engineers educated to more accurate and better methods, the laws of so many states should retain the system of magnetic surveys. More than half the states considered require compass surveys, either by direct provision or by plain implication. The requirement of the laws of Arkansas may be taken as a type of this class of antique legislation; here the county surveyor is required to provide himself with a compass "having nonious division" and a two-pole chain. It is a little difficult to determine why some commonwealths, like Ohio, should require the computation of acreage by the accurate method of latitudes and departures, while still clinging to needle work; but perhaps it is the entering wedge tending toward improvement that may finally succeed in supplanting the compass by the transit, even as the tripod has superseded the Jacob's staff in supporting that well-meaning old instrument. As long as magnetic surveys shall obtain, the requirement of some states that the magnetic declination (at the time of the survey) shall be indicated on the map is a thoroughly commendable demand. Likewise the provision of some states, like Maryland, that the county may erect a "needle-point" and "hair-sight" marking the true meridian and provide a standard measure 1 rod in length, with which county surveyors must compare their compasses and chains at least once a year, tends to better results.

Usually the county surveyor provides his own instruments; but in North Carolina the county is required to purchase and own the "surveyor's instrument and chain." As for qualifications required by the state laws, they seem practically wanting except in the relation established between the county surveyors and surveyors-general of California and South Dakota, as before given, and in New Mexico, where this officer must be a practical land surveyor, engaged in the business. Removal for inefficiency, or for any other cause, is controlled in the usual way. Only occasionally is there a special efficacy attaching to a survey because made by the county surveyor; in Arkansas, only his surveys are legal evidence in court, unless it be a survey made under United States authority or by consent of the parties.

The duties of the county surveyor vary with the states, and seem especially dependent upon the date of the legislation; old laws as a rule signify antique methods and provisions. His usual work, which, unfortunately, in a large majority of the states is practically the only duty he is charged with, is making surveys on the application of persons on payment of the legal fee and making surveys for courts of record. In addition to these duties, in Arizona he is a viewer on the opening of public roads; in Colorado, Kansas, Kentucky, Minnesota, Nebraska, North Dakota and Texas he also makes surveys for the opening of public roads; in Nebraska he must also examine and report upon proposed improved roads; in Indiana he is also ex officio drainage commissioner, allotting work on public ditches and having general engineering supervision of them; and in Wyoming he "makes all surveys in and for his county."

More general and extensive duties are given to the county surveyor in the six following states: Missouri makes him ex officio commissioner of roads and bridges. These duties are made more specific and emphatic by New Mexico, where "all county surveying and engineering on roads and bridges shall be performed by the county surveyor, and he shall * * * be one of the viewers in the establishing of new roads or the location of bridges." Montana laws are similar, but grant still great powers to this officer by abolishing the old office of road supervisor and placing his duties upon the county surveyor.* In Ohio he must be employed "whenever the services of an engineer are required with respect to roads, turnpikes, ditches or bridges," except in counties containing cities of more than 200,000 inhabitants. California declares that "he shall make all surveys of county roads, perform other engineering work as the board of supervisors shall direct, * * * advise the board of supervisors regarding all engineering work, and perform all engineering work for the county not otherwise provided for." The Washington law is the most terse and comprehensive of all; "the county surveyor, in person or by deputy, shall make and execute all surveys, and shall be engineer in charge of all construction within his county required by the county commissioners, or by order of any court, or on application of any person therefor," except when he is deemed incompetent. It is a significant fact that all the five last-mentioned and most adequate laws have been enacted within the last six years. In addition to these duties, Missouri avails herself of the services of the county surveyor in making him a member of the county board of equalization; and on the opening of a road, in addition to the usual cares of a road commissioner, charges him with the duty of adjusting (if possible) benefits and damages among petitioners for the opening of the road and those refusing the right of way; but where this arbitration by the county surveyor cannot be effected, the usual proceeding by an assessment commission is followed.

The duties just enumerated furnish all the engineering responsibilities placed upon the county surveyor by the laws of the different states and territories. It is patent that the cases where he is charged with works of importance and responsibility are very few; and until this is done the office will remain an undesirable one to men of training and ability. In addition to the above states which give important duties to this office, Maryland, Michigan, Nebraska and Wisconsin authorize any competent surveyor or engineer to be employed by the county board in investigating and effecting drainage improvements. Would it not benefit all concerned if, like California, Indiana, Ohio and Washington, these duties were charged upon the proper county official, thus tending to make the position one that a man of judgment and ability could afford to take. The same is true of the making of official surveys of town, village or city plats, which Michigan and Montana require to be made by any competent surveyor.

In the same category is the duty of surveying and attending upon the opening of public roads. Alabama, Arkansas, Idaho, Iowa, Michigan, Oregon, Pennsylvania, West Virginia and Wisconsin provide for a surveyor for this purpose, but (unlike the 14 states already given) this is not specified to be the county surveyor. Likewise Alabama, Arkansas, Michigan and Texas provide for the employment of an engineer or commissioner to superintend the work and repairs on public roads (Texas, e. g., allowing a salary of $1,200 for such service), but he need not be the county officer who would properly attend to these duties, as in the six states mentioned that do so provide. Again, in the important question of the design and erection of bridges one wonders at the technical skill of the boards of county commissioners of Idaho, Kansas, Maryland, and Nevada, where they are charged with preparing plans and specifications for these structures; Oregon is at least business-like in allowing the bidders to furnish the plans. Still more to the point are the laws of Alabama, Arkansas, Indiana, Kentucky and Minnesota, authorizing the appointment of an engineer for this purpose; but he is not specified to be the county surveyor as in the six states so requiring.

Continuing this line of inquiry to include the subject of improved roads, it is evident that the five states taking this work under their own control* would have their own engineers to plan and supervise the work; and yet even here there is (or will be) abundant opportunity for the services of a competent county surveyor to engage in similar construction on other roads of the county; for it is the policy of all such states to foster and encourage each county (by their aid and example in building the "state aid" roads) to itself improve its far more numerous and extended roads not receiving state aid. In addition, six states have been mentioned whose county surveyors are placed in charge of any such work, though it must be said that in a part of them there has been practically no construction up to the present time. Besides these there is a minority, consisting of Illinois, Indiana, Kentucky, Minnesota, Oregon, Pennsylvania, Virginia, West Virginia and Wisconsin, that see fit to designate any engineer for this purpose whenever there may be roads to substantially improve. Perhaps, however, county surveyors in one state at least may rejoice that they are not specified; for Indiana allows the engineer of its "extraordinary road improvements" not more than $4 per day, while the superintendent of construction of its "free gravelled roads" receives $1½. Still more self-beguiling in securing skillful and reliable service are the laws of another of these states, which provide for advertising for competitive bids for the engineer and superintendent of state roads, who cannot be paid "a larger salary per annum, or for a greater or less time, than the superintendence of such work can be let to the lowest bidder deemed competent" (Va.). Is there any connection between laws of this delusive nature and the failure of the state to engage in the improvements so contemplated and hoped for.

It is true that, either the surveying and viewing for opening new roads, or the design and erection of bridges, or the superintendence of highway construction, or the making of town and village surveys, or the supervision of drainage improvement, or the engineering plan and control of the construction of good roads would (in the usual case occurring) not add greatly to the duties or emolument of a county surveyor. But each and all of these duties would most properly fall to him, and, combined, they would add materially to his work. Even now they would be of substantial advantage to the average county surveyor, whose employment occurs perhaps half-a-dozen times each month and at a return of four or five dollars per day of actual work. Such fragmentary employment and so attenuated an income cannot hold the services of a trained and capable engineer, even if adverse circumstances force some into such a position for a time; and the counties need and require such services. Cases are constantly appearing, in engineering publications and in individual experience, where town and county officers lose in imperfect and insecure work much more than would be the expense of professional supervision securing correct and adequate construction.

The logical and advantageous course is for the states to follow the lead of the few more progressive ones, and place (with proper safeguards) the duties mentioned under the county surveyor. This would call to the office and keep in it men of ability, the more so as the development of the country's resources increases, and the importance of public works becomes more appreciated and their construction becomes a necessity. While some may fear that the proper material for such officers might fail, it is still true that there is a very considerable supply of engineers, trained in similar duties, that might be drawn upon if the inducements offered were reasonably substantial and certain. Neither, judging from past experience, is it at all probable that such adequate and commensurate laws will be passed by the state legislatures with a rapidity that will endanger the supply. But still more pertinent is the fact that our engineering schools are graduating a numerous band of civil engineering students, whose services could readily be directed to such an opening, with satisfaction to the engineer engaging in this new field and to the certain material advantage of the county employing him.

It will not be amiss to advert to the advantage of having the county surveyor act as an arbitrator. Reference has already been made to the commendable statute of one state giving legal sanction to such "good offices" on his part in connection with the opening of public roads. But legal sanction is not necessary to give effect to his peaceful settlement of private disputes over lands and boundaries, which would naturally fall to his sphere. His office, duties, training and professional standing would naturally qualify the county surveyor most peculiarly for this duty of decreasing the work of the crowded courts and saving the temper and financial resources of the property owners. This service, whether charged by law or self-imposed, should form the proudest guerdon of the county surveyor's work.

*Engineering News, Vol. XXXVII., p. 177.

*Engineering News, Vol. XXXVII., p. 179.

TEN-WHEEL PASSENGER LOCOMOTIVE; ATCHISON TOPEKA & SANTA FE RY.

(With two-page plate.)

Among recent additions to the motive-power equipment of the Atchison, Topeka & Santa Fe Ry. are eight passenger engines of the ten-wheel type, built by the Dickson Mfg. Co., of Scranton, Pa. The general design was prepared in the railway company's offices, under the supervision of Mr. John Player, Superintendent of Machinery, and Mr. George A. Hancock, Assistant Superintendent of Machinery. The detail drawings were worked out by the builders, but the following parts are made in accordance with the standards adopted by the railway company; steam chest and valves, eccentrics and straps, driving boxes, driving shoes and wedges, crown sheet support, smokestack, pilot, tender, tender frame, and engine and tender trucks.

The engines are intended to run between Topeka and Dodge City, Kan., 288 miles, and between Dodge City and La Junta, Colo., 202 miles. The accompanying profile, Fig. 1, shows the character of the line, with the rates and lengths of grades. Mr. Hancock informs us that the country is open, and during the winter the heavy winds cause greater resistance than the curves. The average train consists of twelve cars (4 sleeping cars, 2 chair cars, 2 day cars and 4 baggage, mail and express cars), but frequently there are as many as 14 cars. On the westbound trips (up grade) the time allowed is 10 hours from Topeka to Dodge City (28 miles per hour), and 6 hours 40 mins thence to La Junta (33 miles per hour). On the westbound trips (down grade) the time allowed is 5 hours 45 mins., from La Junta to Dodge City (35 miles per hour), and 9 hours 20 mins. thence to Topeka (30 miles per hour). These particulars show the character of the work the engines have to do, but the speeds given are from start to finish, exclusive of stops. These engines will replace engines having cylinders 19 × 26 ins., and driving wheels 5 ft. 3 ins. diameter.

The pistons have tail rods passing through the front cylinder covers; and the crossheads and guides are of the Laird type, the guides extending beyond the yoke. The long valve rod is supported by a bushed bearing in this guide-yoke. The connecting rods are of I-section, while the coupling rods are of rectangular section, fish-bellied in shape, with solid ends. Cast-steel centers are used for the driving wheels, and the trailing axle has the spring hangers arranged in a manner somewhat different from that ordinarily employed, as may be seen by the sectional elevation, Fig. 2. The hangers form a horseshoe or yoke, resting on the axle box, and carrying a short equalizer below the box, the strap of the spring being secured to the middle of this equalizer by a link and pin. All the spring hangers are connected to the equalizers by pins. Some cross-sections of the engine are shown in Fig. 3.

The boiler is of the extended wagon-top type, with the sandbox on the throat sheet and the dome on the wagon-top. The bell is mounted behind the dome, which is an unusual position. The style of horizontal seam is shown in Fig. 4. In the smokebox the exhaust nozzle is set low, and a double petticoat pipe is placed between the nozzle and the base of the smokestack. The firebox is made shorter than in the engines which formerly

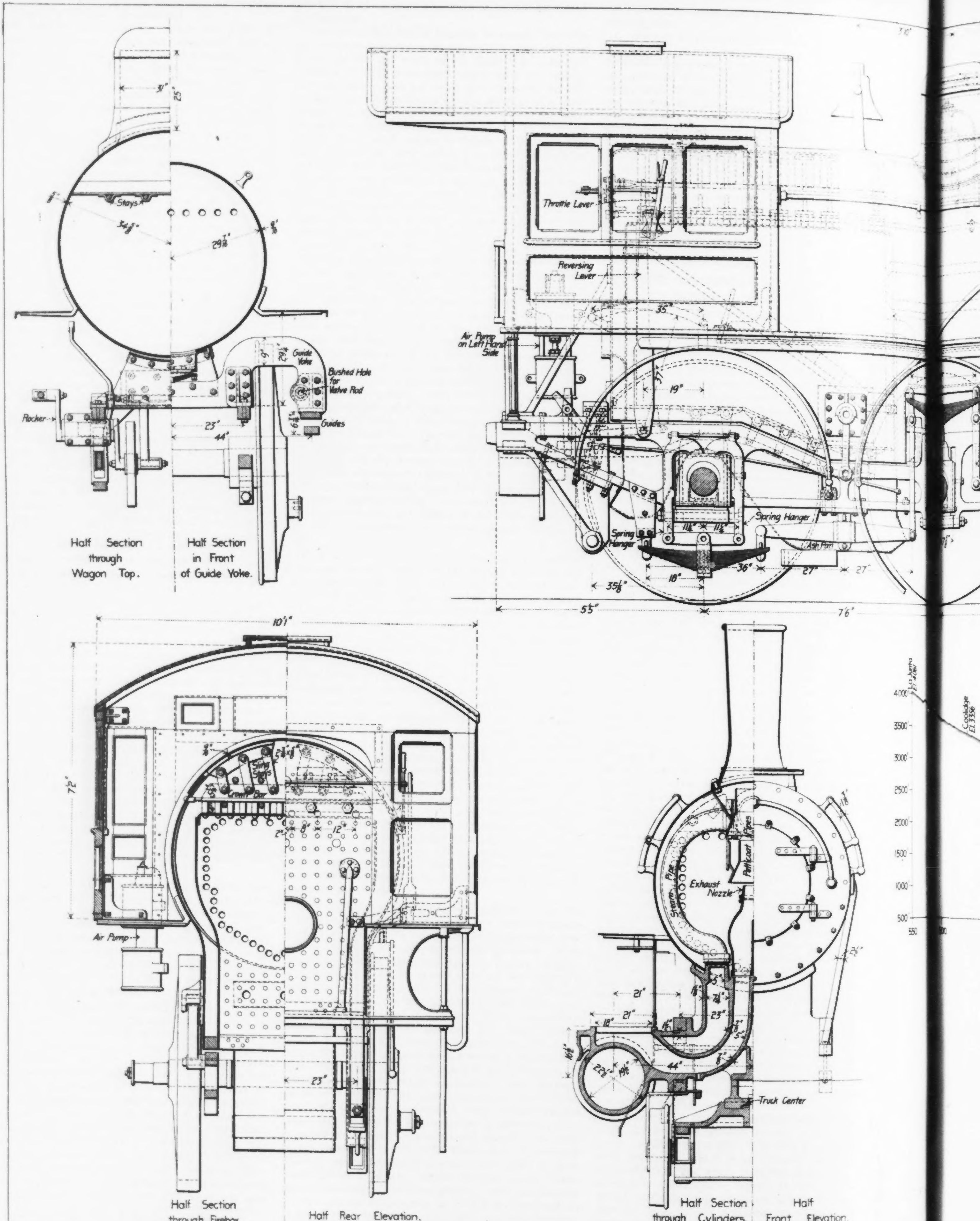


FIG. 3. CROSS SECTIONS.

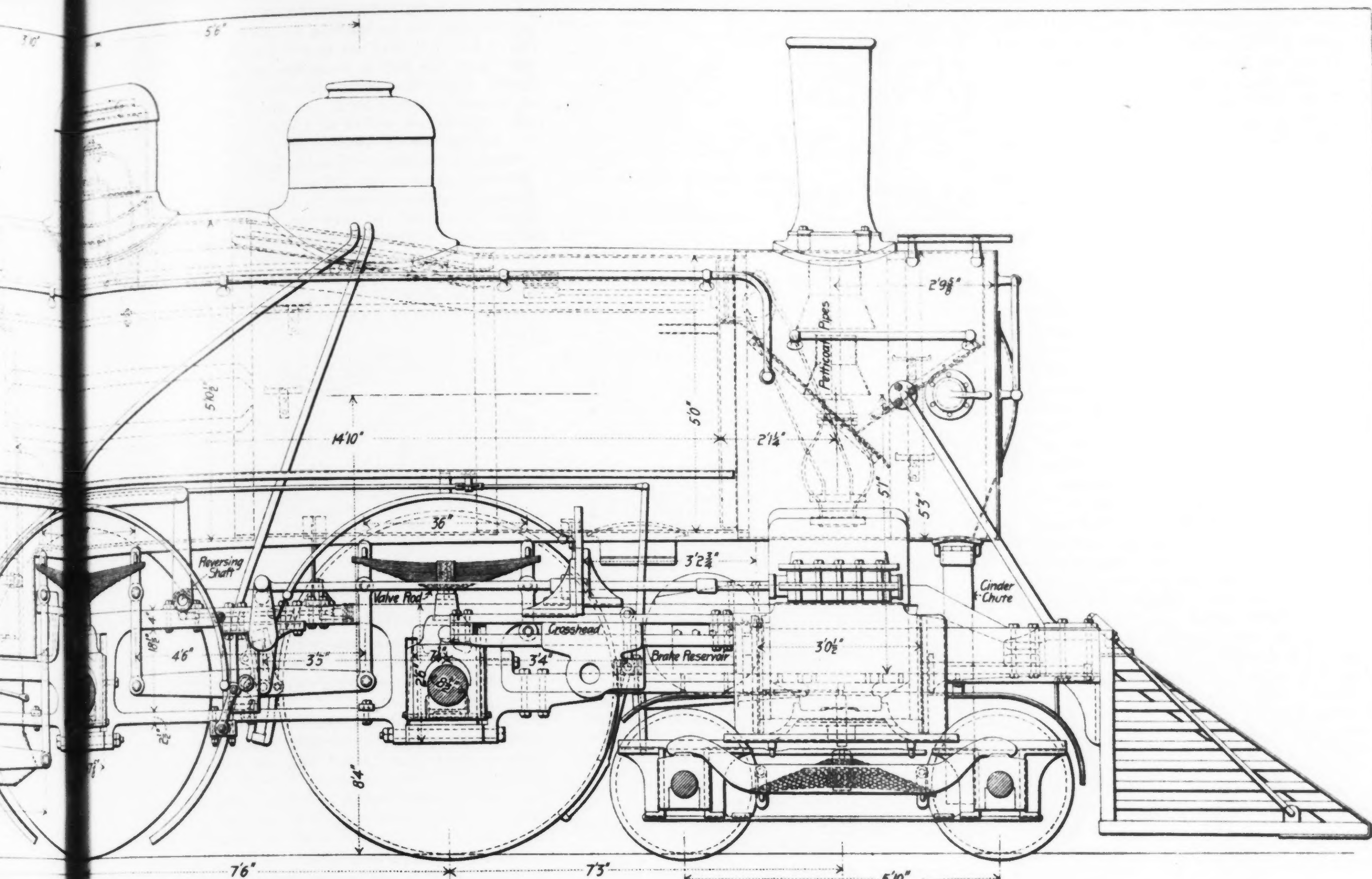


FIG. 2. SECTIONAL SIDE ELEVATION.

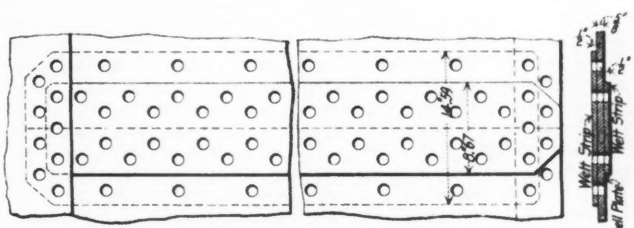


FIG. 4.
HORIZONTAL SEAM OF BOILER.

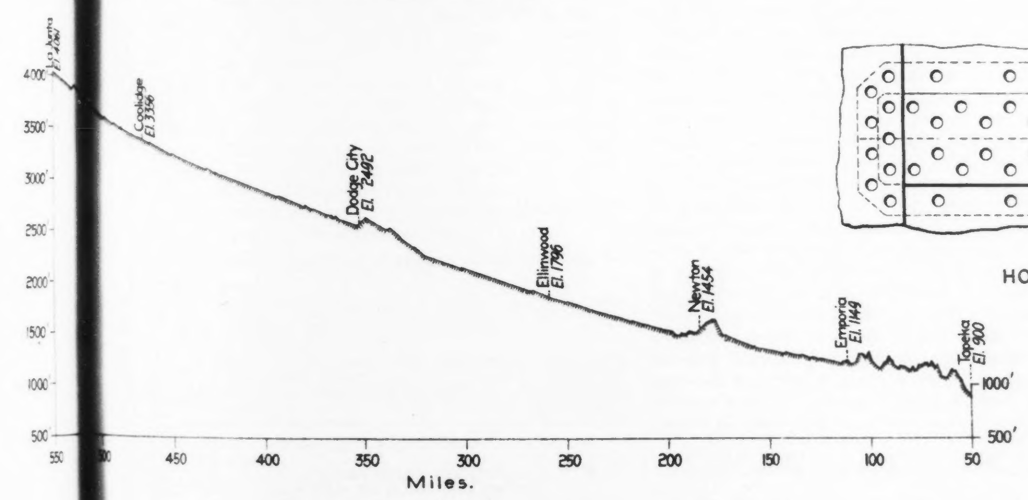


FIG. 1. PROFILE OF A., T. & S. F. RY. FROM TOPEKA, KAN., TO LA JUNTA, COLO.

TEN-WHEEL PASSENGER LOCOMOTIVE;

Atchison, Topeka & Santa Fe Ry.

John Player, Superintendent of Machinery. Dickson Mfg. Co., Scranton, Pa., Builders.

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

ran in this service, on account of the difficulty in maintaining a good fire at the end of a long grate and the injurious effects of a dull fire upon the tube sheets and ends of tubes, especially when both fuel and water are of inferior quality, as in this case. The firebox is above the frames, the upper members of the frame being inclined to conform to the slope of the front portion of the firebox and grate. It has a flat crown sheet, with Mr. Player's arrangement of crown staying. Brackets of T-iron riveted to the roof of the boiler carry inclined sling stays which support transverse crown bars of T-section. These bars are attached to the crown sheet by long rivets with 4-in. thimbles, leaving a space of 4 ins. between the crown-sheet and bars, for convenience in washing out.

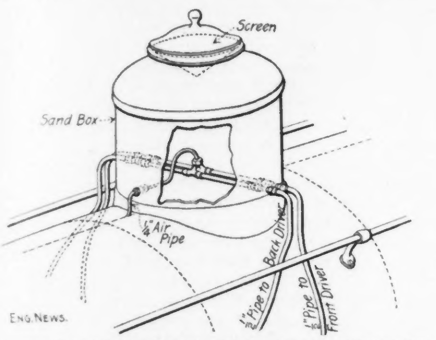


Fig. 6.—Houston Sanding Apparatus on Locomotive for the A., T. & S. F. Ry.
Western Railway Equipment Co., Manufacturers.

The tender has frames of 9-in. steel channels, and is carried on two four-wheel trucks, having diamond frames and the Player cast-steel bolsters. The wheels have wrought-iron centers and steel tires. The tank is built of ¼ and 5-16-in. plate, and is 19 ft. 6 ins. long, 9 ft. 1 in. wide, and 4 ft. 8 ins. high (exclusive of the collar).

The air pump for the brakes is placed under the cab, on the fireman's side of the engine, instead of in its more usual position above the running board. The fittings include the Rushford feed-water heater and the Houston sanding apparatus. This latter apparatus, which is shown in diagram in Fig. 5, has ½-in. air pipes let into the heads of the sand pipes, thus blowing the sand through the pipes, and the ends of these pipes are so curved as to blow the sand directly under the wheel, instead of simply dropping it on the rail in advance of the wheel. This device is manufactured by the Western Railway Equipment Co., of St. Louis, Mo.

The following is a list of dimensions of these engines, given in our standard form:

Dimensions of Ten-Wheel Passenger Locomotive; A., T. & S. F. Ry.

Running Gear:
Driving wheels (6), diameter ....6 ft. 1 in.
Truck wheels (4), " ....2 " 6 "
Tender wheels (8), " ....2 " 9 "
Driving wheel centers:
Middle........Cast steel; front and back.....Cast iron
Truck and tender wheels ....Steel tired
How are driving-wheel tires secured?......By shrinkage
Engine truck ....Rigid center
Journals, driving axles....8½ × 10 ins.

Wheelbase.—Driving..15 ft. 0 ins.; Truck...... 5 ft. 10 "
Total engine ....25 " 2 "
Tender......16 ft. 6 ins.; Engine and tender..50 " 8 "
Center of engine truck pin to center of leading driving wheel ....7 " 3 "
Wheels having blind tires ....Middle pair

Weight in Working Order:
On driving wheels....125,300 lbs.
On truck wheels ....31,500 "
Engine, total ....156,800 "
Tender, empty.......41,666 lbs.; loaded..... 92,400 "
Water in tank....38,734 "
Water in boiler (3 gages)....17,251 "
Coal on tender ....16,000 "
Does counterbalance conform to M. M. Assoc. rules? Yes.
Weight of piston (including piston rod)..........463 lbs.
Weight of crosshead....294 "
Main rod ....653 "
Side rod ....710 "

Cylinders:
Diameter and stroke ....19½ × 28 ins.
Cubic contents of all cylinders ....9.68 cu. ft.
Form of crosshead and guides ....Laird
Connecting rod, length between centers....10 ft. 1¾ ins.
Side rod ....Solid ends

Valve Gear.—Type ....Shifting link
Ports, steam.....1⅝ × 18 ins.; Exhaust.......3 × 18 ins.
Bridges, width........1⅜ "; Eccentrics, throw.5¼ "
Slide valves ....Richardson balanced
" " max. travel ....5⅝ ins.
" " inside lap..0 in.; outside lap....1 in.
" " lead (full forward gear)....1-16 "
" " lead (full backward gear)....1-16 "

Boiler.—Type........Extended wagon top
Diam. barrel inside smallest ring..........4 ft. 10⅞ ins.
Dome, diam....2 " 6 "
Thickness barrel plates ....9-16 and ⅝-in.
Smokebox tube-plate ....½ "
Horizontal seams ....Butt-joint, quadruple riveted
Circumferential seams........Lap-joint, double riveted
Rivets, diameter ....1 in.
Height from rail to center line....8 ft. 4 ins.
Length of smokebox (including extension).....5 " 1 "
Does smokebox arrangement conform to M. M. Assoc. rules? ....Yes
Form of spark arresting device.... Wire netting and deflecting plates
Injectors, number ....2; kind ....Monitor
Working steam pressure ....180 lbs.

Firebox ....Above frames
Length inside....7 ft. 4 ins.; width inside.....3 ft. 5 ins.
Depth at front....6 " 0 " ; depth at back.....5 " 0 "
Thickness, side plates.⅜-in.; back plate....⅜-in.
" crown plate.½ " tube plate..........9-16-in.
Kind of crown stays ....Steel T-irons
Kind of grate bars ....Cast-iron rocking
Is fire-brick arch used? ....Yes
Stay bolts—hollow, 1¼ ins.; solid, 1 in.; pitch....4 ins.
Water spaces, width at front, back and sides......4 "

Tubes.—Material..Lap-weld charcoal iron; Number..264
Thickness ....No. 11 W. G.; Pitch ....2⅞ ins.
Diameter, outside....2 "
Length over tube plates ....14 ft. 10 "
Total area of tube openings ....5.75 sq. ft.

Heating Surface and Grate Area:
Heating surface, tubes (interior area)......1,796 sq. ft.
" " firebox.... 150 " "
" " fire-brick arch tubes...... 14 " "
" " total ....1,960 " "
Grate area .... 25 " "
Ratio of total heating surface to grate area...78.36 to 1
Ratio of interior tube area to firebox heat. surf.11.97 to 1
Sq. ft. total heat. surf. to 1 cu. ft. cyl. vol..202.37 sq. ft.
Sq. ft. firebox heat. surf. to 1 cu. ft. cyl. vol. 15.50 " "
Sq. ft. tube heat. surf. to 1 cu. ft. cyl. vol...185.33 " "
Sq. ft. of grate area to 1 cu. ft. of cyl. vol... 2.58 " "

Miscellaneous:
Exhaust nozzle, single, diameter..........5 to 5½ ins.
Exhaust nozzle, distance below center line boiler..1 in.
Smokestack, diameter at top ....17½ ins.
" diameter at base....14½ "
" height above smokebox.......3 ft. 11 "
" height of top above rail......14 " 10 "
Capacity of tender tank....4,650 gallons
" of coal space ....16,000 lbs.
Brake fittings .... Westinghouse train; American driving wheel
Tractive force per lb. effective press. on piston...145.8
Total tractive force with effective press. equal to 85% of boiler pressure....22,315
Total adhesive tractive power at ¼ of weight on driving wheels 31,325
Ratio tractive force to weight on driving wheels.1 to 5.61

TESTS OF A CORRUGATED FURNACE "GUNBOAT TYPE" BOILER.

In our issue of Nov. 26, 1896, we illustrated and described a new boiler designed by Messrs. Dean & Main, mechanical engineers, 53 State St., Boston, Mass., and built by the Atlantic Works, East Boston, for the Washington Mills, Lawrence, Mass. The boiler was designed especially to suit the conditions of a large increase of power being required by the mill with no space in which to locate boilers of ordinary types. It was necessary, therefore, to crowd a great deal of heating surface into a small space. The boiler is of the corrugated internally-fired furnace "gunboat" type, about 12 ft. diameter and 28 ft. long, with a 3-ft. smoke box extension. The furnaces, two in number, are 4 ft. 8 ins. diameter, the grates 7 ft. 6 ins. long, and behind the bridge wall there is a large combustion chamber 5 ft. long and 6 ft. 8 ins. high. There are 590 tubes, each 2½ ins. diameter, 14 ft. long. The grate surface is 60 sq. ft. and the water-heating surface 5,300 sq. ft., the unusually large ratio of heating to grate surface, 85.2 to 1, being chosen because it was expected that the boilers would be hard-driven, and it was desired to economize fuel as much as possible under the circumstances. A peculiar feature of the boiler is that there are three dampers in the smoke stack, each controlling one of three portions into which the smoke box in the rear of the boiler is divided by curtains or partitions hanging in front of the tubes. By these curtains and dampers it is designed to equalize the flow of the heated gases through all the tubes, and to prevent their short-circuiting through the upper tubes, which is a common trouble with horizontal tubular boilers. Two boilers of this description were installed in the Washington Mills, and they have recently been tested with both New River and Pocahontas coal, by Messrs. Dean & Main, to whom we are indebted for a copy of the results which we give herewith in condensed form. The two boilers were tested together, and the quantities obtained were halved so as to apply to one boiler.

The coal used was not analyzed, nor was its heating value determined by a calorimeter, and the "efficiency" is, therefore, not given in the report by Messrs. Dean & Main. We have added the estimated efficiency in the last line of the annexed table, calculating it by dividing the figures given for "heat units imparted to the boiler per lb. of combustible," by 15,800 B. T. U., which is approximately the heating value per lb. of the combustible portion of both New River and Pocahontas coals. The actual value is not apt to vary as much as 2% in either direction from this figure.

There are several things about the results of these tests which we consider worthy of more attention than published results of boiler tests usually receive or deserve. In the first place, the economical results are very high, but not higher than have been reached before with coals of similar quality. They are so high, however, that they may well serve as a standard of reference for other tests, which standard other boilers may be expected to approximate when run under the most favorable conditions, but which they may not be expected to exceed.

The average evaporation in the three tests with Pocahontas coal was 12.63 lbs. from and at 212° per lb. of combustible, and in the three tests with New River coal 12.53 lbs. The average efficiencies, as estimated by us, are, respectively, 77.2 and 76.6%. The highest evaporation, 12.96 lbs., was obtained from the New River coal, but it was almost exactly equalled by the Pocahontas coal, 12.93 lbs. These figures are remarkably close to those obtained by Mr. F. W. Dean four years earlier, in a test of a Belpaire fire-box boiler, with Cumberland coal, as reported in our issue of Feb. 1, 1894. In two tests, made on consecutive days, the evaporation was 12.88 and 12.90 lbs. from and at 212° per lb. of combustible. The efficiencies were reported in these tests as 77.23 and 78.87%. In the first of these two tests the rate of evaporation was only 1.63 lbs. per sq. ft. of heating surface per hour, and in the second 3 lbs. The rate of combustion in the first test was only 8.85 lbs. per sq. ft. of grate per hour, or but little over a fourth of the highest rate reached in the tests now reported.

The first four out of the six tests at Lawrence are remarkable for an usually high rate of com-

Test of a Corrugated Furnace Multi-Tubular Boiler, at Washington Mills, Lawrence, Mass., December, 1897, and January, 1898.

(Boiler designed by Dean & Main, Boston, Mass. Kinds of Fuel, Pocahontas and New River. Kind of Trial, Standard fresh wood fire. Boiler grate surface, 60 sq. ft.; water heating surface, 5,300 sq. ft.; ratio, 1 to 85.

	Kind of Fuel.					
	Pocahontas.	New River		Pocahontas.	New River.	Pocahontas.
Date of trial	Dec. 22.	Dec. 23.	Dec. 30.	Dec. 31.	Jan. 4.	Jan. 5.
Duration of trial in hours	11½	11½	11½	11½	11½	11½
Steam pressure by gage, per sq. in., lbs	122.30	123.20	123.00	122.56	118.50	122.9
Force of draft between damper and boiler, ins. of water.	0.875	0.845	0.89	0.89	0.44	0.41
Average temperature, deg. F., of feed-water	36.7	36.7	37.5	36.0	37.9	38.7
" " " escaping gases	526	516	496	511	472	482
Moist coal consumed, lbs	22,820	20,113	20.078	21,388	15,323	15,125
Moisture in coal, %	5.09	4.47	3.19	6.61	5.2	6.00
Wood consumed, lbs.	456	536	520	591	501	514
Total dry coal, including wood equivalent, lbs.	21,842	19,428	19,646	20,211	14,727	14,423
Dry refuse, %	9.28	8.66	8.72	9.98	8.79	9.28
Total combustible, lbs.	19,814	17,795	17,933	18,193	13,431	13,085
Moisture in steam, %	0.5	0.5	0.5	9.5	0.5	0.5
Heat units imparted to boiler per lb. combustible, B.T.U.	12.048	12,519	11,907	12.047	11,879	12,487
Water evaporated, corrected for quality of steam, lbs.	201,609	188,153	180,414	184.968	134.929	138,187
Equivalent water from and at 212° F., per hour, lbs.	21,493	20,058	19,233	19,751	14,373	14,708
Water actually evaporated, per lb. of dry coal, lbs.	9.23	9.68	9.18	9.15	9.16	9.58
Equivalent per lb. dry coal from and at 212° F., lbs.	11.32	11.87	11.25	11.24	11.22	11.73
Equivalent per lb. combustible from and at 212° F., lbs.	12.47	12.96	12.33	12.48	12.31	12.93
Com'l HP., basis 34½ lbs. water from & at 212°F., pr hr.	623	581	557	572	416	426
Heating surface, per HP., sq. ft.	8.51	9.12	9.5	9.26	12.72	12.42
HP. per sq. ft. of grate surface	10.38	9.69	9.29	9.54	6.94	7.10
Dry coal burned per sq. ft. of grate surface per hour, lbs.	31.66	28.1	28.5	29.3	21.3	20.9
Water evap., sq. ft. htg surf, pr hr., from & at 212°F., lbs.	4.05	3.78	3.63	3.72	2.71	2.77
Efficiency (estimated by Editor Engineering News), %	76.3	79.2	75.4	76.3	75.2	79.0

bustion of semi-bituminous coal under stationary boilers, due to burning the coal with a draft pressure of about 0.9 ins. of water column. The high results obtained in these four tests would seem to be sufficient proof that high economy is quite consistent with high rates of combustion, provided there is enough heating surface to absorb the heat generated, and a sufficient answer to the old fallacy that is still often heard that slow combustion is necessary for economy.

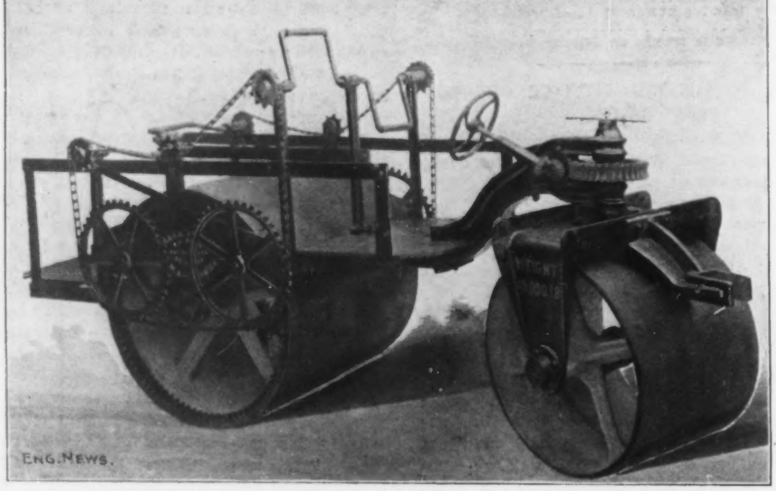
It also appears from these tests that in driving the boiler up to a rate of about 4 lbs. evaporation per sq. ft. of heating surface per hour its rate of evaporation for maximum economy had not been exceeded, and the temperature of the chimney gases was still fairly low. It would be interesting to obtain results from this boiler driven at a still more rapid rate.

The very high percentage of moisture in the coal is explained in a letter from Mr. Dean, in which he says that the coal was taken from out of doors, and that it had been in a recent rain and snow storm. The firing was done by the regular mill firemen.

A NEW ASPHALT ROLLER OPERATED BY HAND POWER.

We illustrate herewith a four-man-power asphalt paving roller, for which several advantages are claimed over steam rollers, particularly in places where a roller is required only at intervals. This roller is manufactured by the Pope Reversible Street Roller Co., of St. Louis, Mo.

The roller illustrated weighs 10,000 lbs., of which 6,000 lbs. are on the rear roller and 4,000 lbs. are on the front roller. Three men are required to propel the machine and one to guide its operations. With this force it is claimed that the roller can operate on an 8% grade. The mechanism by which the power is transmitted to propel the roller is so clearly shown by the illustration as to need no further explanation. The connection for horses is to enable the roller to be transported from one piece of work to another more rapidly and easily than would be possible by hand power. Briefly summarized, the advantages of this roller are that it requires no especially skilled operators and attendants, costs nothing for fuel, water, etc., and is not so likely to frighten horses as a steam roller. When idle, the operators can be put at work elsewhere, and no labor is lost. This style of roller is, of course, built to order in other sizes and weights when desired. The 5-ton roller shown here is the standard size. Its rear roller has a 4-ft. face and is 5 ft. in diameter, and the front roller has a 3-ft. face and is 4 ft. in diameter.



A ROLLER OPERATED BY HAND POWER FOR LAYING ASPHALT PAVEMENT.
Pope Reversible Street Roller Co., St. Louis, Mo., Builders.

FAST TRAINS IN GREAT BRITAIN AND THE UNITED STATES.

A recent issue of the "London Times" contains a most interesting comparison of the speeds of fast trains in England and America, written by a contributor who has personally investigated the matters of which he writes. There has been much incredulity expressed on the other side of the water respecting American express train service; and we trust that this article, published in a journal which, to say the least, is not disposed to unduly praise things American, may serve to convince those who have hitherto refused to believe in the superiority of American express train service. We quote from the article as follows:

In everything that makes railway traveling safe, rapid and convenient America is the only country which can seriously dispute our English primacy. Ten years ago a comparison between English and American express speeds would have been out of the question. But to-day, while the quantity of our fast and very fast trains is still quite unmatched in the States, it must be confessed that the quality of the very fastest American trains is such as we cannot pretend to equal. Most wonderful of all is the Atlantic City express of the Reading Company, which ran last summer during the holiday season from Philadelphia to Atlantic City, on the New Jersey coast. The distance is 56½ miles, including a mile of steamboat ferry across the Delaware River to Camden, whence the train starts. The time allowed was one hour exactly, out of which eight minutes were allotted to the ferry, leaving 52 for the rail journey. In fact, eight minutes proved too short, the train never got away on time, and some days it was almost four minutes late in leaving. Yet in the whole two months that it ran the train arrived punctually once, and before time on the remaining 51 occasions.

The fastest time for the 55½ miles was 46¾ minutes, equal to 71.2 miles an hour; the slowest 50 minutes, equal to 66.6 miles per hour; the average time was 47 minutes 52¼ seconds, equal to, say, 69½ miles an hour.

The natural service to compare with this is that from London to Brighton. Brighton is more than six times as large as Atlantic City, and London more than four times as populous as Philadelphia. The Brighton service commences, not by a ferry from Charing Cross Pier and a transfer of passengers from boat to train, but direct from the London Bridge terminus; and the Brighton distance is six miles less. Yet the best Brighton express takes 65 minutes, as against one hour to Atlantic City. The Brighton Company, it is true, has one heavy gradient of 1 in 100 for 2½ miles outside Newcross, while the New Jersey road is as level throughout as the remaining 48 miles of the English route. On the other hand, the Brighton Company has no trouble with level crossings; the Reading train has to run cautiously through and across the streets both out of Camden and into Atlantic City. Moreover, the Brighton express is first class only, with a minimum fare of 8s. 6d.; to Atlantic City the fare is $1, or less than half. The normal weight of the "Flier" was 156 tons, or, roughly, equal to 15 ordinary Brighton coaches.

But it would obviously be unfair to cite the Brighton line as typical of English railways. Let us take another comparison. The Empire State Express of the New York Central runs the 440 miles from New York to Buffalo in 8¼ hours. There are four intermediate stops. The weight of the train is 175 tons, which is roughly equal to 11 of our East Coast Joint Stock six-wheelers. The East Coast's best train to Perth, a mile and a half further from King's-Cross than Buffalo is from New York, takes 9 hours all but one minute, while the West Coast takes 21 minutes longer again over its 8½ miles longer route. In the matter of gradients it should be said that the American line has probably some slight advantage, though there is a long climb for 9 miles out of Albany, starting on a gradient of 1 in 56, which is much worse than anything which the East Coast companies have to deal with. But I confess to thinking that the difference of gradients, such as it is, would make practically no difference if the American engines were set to haul the English trains. The American locomotives are so enormously powerful that moderate gradients produce no apparent slackening of speed. An American superintendent expects his engines to be able not only to keep but to make up time, however fast they may be booked. To give one instance, the Empire State train is allowed 80 minutes for the 68½ miles from Rochester to Buffalo, the last three miles of which are through the streets of Buffalo itself. The day I traveled by it we left Rochester six minutes late, and in spite of a bad check bringing us down to walking pace, at a point where the line was being slewed over, we drew up at Buffalo station two minutes before time.

On this run I had a good opportunity of satisfying myself that American engines, whether the cause be their more flexible frames, their equalizing levers, or possibly even the more elastic permanent way, do indubitably "ride" more smoothly than our English locomotives. From notes jotted down in the "cab," which I can now read, as I then wrote them, without any difficulty, I see that for 21 consecutive miles our speed ranged between 70 and 80 miles an hour; for the whole 21 miles our time was 16¾ minutes, or an average of about 75¼ miles an hour. Good as this was, I think the previous run of the same engine, Syracuse to Rochester, 80⅓ miles in 80 minutes, start to stop, was even more remarkable.

I returned from Buffalo to New York by another famous train, the "Black Diamond" express of the Lehigh Valley Company, one of the so-called "coaler" roads, which serves the anthracite regions of Pennsylvania. In this case the time allowed was 9 hours and 38 minutes, but the distance is 7½ miles further than by the New York Central. There are 11 intermediate stops, as against four, and the line, instead of following the level valleys of the Hudson and the Mohawk, has to climb over three summits of 924, 1,141 and 1,759 ft., respectively. The weight of the train was 165 tons, except for about 100 miles, during which the addition of an extra Pullman car brought it well over 200 tons. We were five minutes late in starting, and before we had gone very far we were stopped by an axle-box on the Pullman car heating.

The natural result was that we reached Geneva, about 100 miles from Buffalo, 12 minutes late. Thence to Sayre, 73½ miles, we were timed to take 86 minutes, but we covered the distance in 74, and so came in exactly to time. I had timed 20 minutes in different places done at speeds of from 72 to 80 miles an hour. Soon after leaving Sayre we were brought up short by a broken-down freight train, two of whose cars had got off the track and blocked both lines. So we were 33 minutes late at our next stopping place. Then we set to work again to recover our lost ground, till finally we reached Jersey City only 15 minutes late. We had come in the last 77 miles from Easton in 79 minutes, as against 90 minutes allowed in the time book, and we had stopped at two important intermediate stations. Swindon to Paddington is also 77 miles, and an even more level road. But the Great Western trains—and no line in this country runs finer expresses—are allowed 87 minutes for the through run to Paddington, and never less than 110 minutes if they have to call at Didcot and Reading. The real comparison, however, to the "Black Diamond" should be made with the best Midland express to Perth. Like the Midland, the Lehigh Valley has heavier gradients than its rivals; like the Midland it runs through a district congested with heavy coal and iron traffic; but, unlike the Midland, it has a long stretch of single line. The Midland's distance is 7½ miles further, and there are 17 intermediate stops, as against 11. A handsome allowance for the extra miles and the extra stops would be 45 minutes, but the extra time allowed by the Midland is, in fact, over two hours.

Admirable as these American trains are on paper, they are yet more admirable in practice from the fact that they run with almost absolute punctuality. Few English railway men will be found to deny that punctuality is the weak point in our services. Everywhere in America I found that, whether by officials, train staff, or by the traveling public, punctuality is taken for granted. And, if I may judge by my own experience, after traveling some 6,000 miles, it is so taken with good right. We are told that punctuality in England is more difficult of attainment owing to the crowded condition of our English main lines. Granted that our main lines have more trains on them than the great American roads, I am sure they have not more traffic. The Midland, for instance, probably brings, on an average, 10,000 tons of coal a day up to London. Under English methods this implies at least 25 trains. The Pennsylvania or the New York Central would haul the same load in six or seven trains.

And then it must be remembered that in America the lines are almost always single. Take as a typical instance the run of the Pennsylvania Limited between New York and Chicago. On its direct route there are nearly 150 miles of single line, and besides that, at Pittsburg the east-bound train picks up cars from St. Louis and from Cincinnati which have traveled over hundreds of miles of single line in order to make the connection.

Even more important than single lines are the stops and slacks. A train shown in "Bradshaw" as running without a stop, say from London to Crewe, does, in fact, run the whole distance at full speed. Between New York and Albany (143 miles) on the Empire State Express there is no booked stop, but we slacked down eight times, and this is a fair sample of what American engines have to contend with.

Yet another American disadvantage. To say that their expresses are on the average 50% heavier than ours would be, I believe, to understate the facts. Probably the heaviest express in this country is the 2 p. m. corridor train from Euston to Scotland. It weighs, I believe, about on the average of 270 tons. For combination of speed and weight I know of no American train that can match it. But this train is exceptional, and very frequently has two engines—a thing unknown in America. Certainly, except, perhaps, on the Northwestern, our average express cannot be said to weigh more than 120 to 150, or, at the outside, 200 tons. In America 270 tons is still a light train. The Pennsylvania Limited weighs fully 350. I traveled in one or two trains, and I saw many more which certainly weighed 400 tons and upward. I have, for instance, a record of four runs with trains averaging over 500 tons each, the speed being 50 miles an hour from start to stop. Now 500 tons in England would mean an ordinary coal train.

On the whole, then, I believe it is true to say, not only that American trains are punctual, but that they are punctual in spite of difficulties even greater than those our railways have to contend with.

STATISTICS OF THE PRINCIPAL ENGINEERING SCHOOLS IN THE UNITED STATES.

The accompanying table, showing the number of students taking courses in civil, mechanical, electrical and mining engineering in the principal engineering schools of the country during the past eleven years, is taken from a paper on "Some Statistics of Engineering Education," by Dr. M. E. Wadsworth, president of the Michigan College of Mines, Houghton, Mich., read at the Lake Superior meeting of the American Institute of Mining Engineers, July, 1897. The table includes only those schools in which there were 50 or more students taking one of the four engineering courses.

NUMBER OF STUDENTS IN ENGINEERING COURSES IN THE UNITED STATES IN WHICH THERE WERE 50 OR MORE STUDENTS DURING THE PAST 11 YEARS.

	1886-'87.	1887-'88.	1888-'89.	1889-'90.	1890-'91.	1891-'92.	1892-'93.	1893-'94.	1894-'95.	1895-'96.	1896-'97.
Civil Engineering.											
University of California	38	34	49	42	53	52	57	58	83	56	50
Columbia College, School of Applied Science	86	84	82	78	87	100	92	78	84	67	72
Cornell University	112	111	126	134	137	139	126	116	122	119	150
University of Illinois	..	..	..	62	95	87	92	86	82	73	76
Lawrence Scientific School	..	..	..	..	..	..	40	57	44	41	32
Lehigh University	130	148	124	123	116	149	154	144	128	105	84
Leland Stanford, Junior, University	..	..	..	..	..	..	..	63	60	40	38
Massachusetts Institute of Technology	45	50	71	71	79	81	75	78	121	126	99
University of Michigan	57	60	68	76	78	96	93	92	96	87	50
College of New Jersey	37	44	55	55	67	93	152	160	156	109	85
Ohio State University	28	24	20	27	38	36	59	72	70	78	64
Purdue University	..	..	..	34	52	70	..	68	57	68	80
Rensselaer Polytechnic Institute	164	151	167	174	189	185	206	188	165	135	137
University of West Virginia	..	..	..	..	..	..	11	42	33	87	75
University of Wisconsin	17	18	29	27	38	41	45	54	49	45	66
Electrical Engineering.											
Alabama Polytechnic Institute	..	..	..	..	..	13	34	38	39	44	55
Armour Institute	..	..	..	..	..	..	33	49	56	86	..
Columbia College, School of Applied Science	..	..	..	19	21	26	41	87	113	117	134
Cornell University	38	59	83	125	172	214	250	239	211	293	230
University of Illinois	..	..	..	..	1	29	94	123	108	123	90
University of Kansas	..	6	8	14	28	44	54	62	..	64	62
Lawrence Scientific School	..	..	1	6	6	8	31	56	63	65	44
Lehigh University	12	23	41	75	91	118	145	141	136	103	85
Leland Stanford, Junior, University	..	..	..	..	..	..	..	..	78	66	55
Massachusetts Institute of Technology	61	74	91	105	108	105	112	140	163	146	106
University of Michigan	..	..	..	..	..	..	90	93	130	135	87
University of Minnesota	..	..	2	6	29	45	59	50	50	78	62
University of Nebraska	..	..	..	..	..	..	..	..	86	82	80
Ohio State University	..	..	..	..	..	33	65	125	116	138	120
Pennsylvania State College	..	..	10	11	17	22	40	57	68	64	65
Purdue University	..	..	..	35	75	122	..	183	173	153	120
Rose Polytechnic Institute	..	81	107	131	133	139	121	91	76	80	66
University of Tennessee	..	..	..	..	..	..	..	..	5	4	85
University of Wisconsin	9	24	..	9	15	52	56	87	101	97	82
Mechanical Engineering.											
University of California	17	22	24	28	35	30	58	84	108	128	133
Cornell University	63	109	136	158	174	211	250	332	284	200	243
University of Illinois	..	..	..	74	78	8	79	67	86	76	58
Lawrence Scientific School	..	..	..	..	..	..	..	8	27	41	70
Lehigh University	79	91	81	66	63	92	105	115	99	103	96
Leland Stanford, Junior, University	..	..	..	..	..	..	..	98	39	32	19
Massachusetts Institute of Technology	89	100	99	95	104	102	103	95	178	179	117
Michigan State Agricultural College	57	60	93	113	127	114	119	122	121	128	120
University of Michigan	28	32	40	53	65	73	80	99	79	86	52
University of Minnesota	21	65	76	86	43	101	57	15	22	24	27
Mississippi Agricultural and Mechanical College	..	..	..	..	..	..	61	..	73	57	22
University of Pennsylvania	..	..	20	..	40	68	82	140	127	78	104
Pennsylvania State College	10	18	22	21	19	31	44	44	50	45	38
Purdue University	..	..	..	49	67	90	..	118	108	133	142
Stevens Institute of Technology	176	176	185	196	213	210	264	264	256	263	254
University of West Virginia	..	..	..	..	..	..	4	22	25	145	78
University of Wisconsin	24	30	31	43	47	42	33	51	66	51	57
Worcester Polytechnic Institute	100	115	116	73	88	119	132	167	134	129	130
Mining Engineering.											
University of California	17	24	24	25	30	32	24	32	39	60	110
Columbia College, School of Mines	74	51	46	45	48	60	52	51	60	47	44
Lehigh University	58	56	61	68	52	68	64	51	58	43	37
Michigan College of Mines	23	29	40	35	65	78	101	82	94	94	140

Another table in the paper gives a list of all the schools, so far as could be learned, that gave engineering courses, and their statistics are given back to the date of the beginning of each course. It is, we think, the most complete statistical table of engineering courses that has yet been published.

The accompanying table, it will be noted, shows a considerable falling off in the number of students taking courses in civil, electrical and mechanical engineering in many of the schools during the last year. In mining engineering, two of the schools, the University of California and the Michigan College of Mines, show a large increase in the past year. The following are the totals of the last four columns in the accompanying tables:

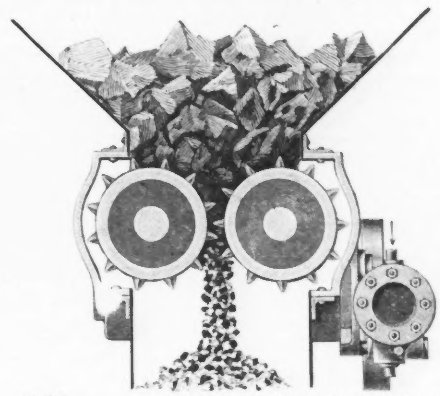
Students in Engineering Courses in Leading Schools.

	1893-4.	1894-5.	1895-6.	1896-7.
Civil Engineering	1,356	1,350	1,236	1,158
Electrical Engineering	1,621	1,772	1,938	1,628
Mechanical engineering	1,841	1,882	1,898	1,760
Mining engineering	216	251	244	331
Total	5,034	5,255	5,316	4,877

A NEW BITUMINOUS COAL CRACKER.

The device here illustrated is intended to break the large lumps of bituminous coal as they come from the mines into pieces small enough to feed through the automatic stokers used in connection with large steam generating plants. The resulting smaller sizes admit of easier and better distribution of the coal on the grates, and a more perfect combustion and, consequently, an evener fire.

This cracker is made up of two rolls driven by a direct-connected steam engine. The steam enters



N° 9802 COPYRIGHT 1898 BY C. W. HUNT CO. N. Y

Fig. 1.—Cross Section of Cracker for Bituminous Coal. Made by the C. W. Hunt Company, New York City.

the cylinder of this engine at the top, and the exhaust passes out at the bottom; and the steam ports and passages are arranged to drain down-

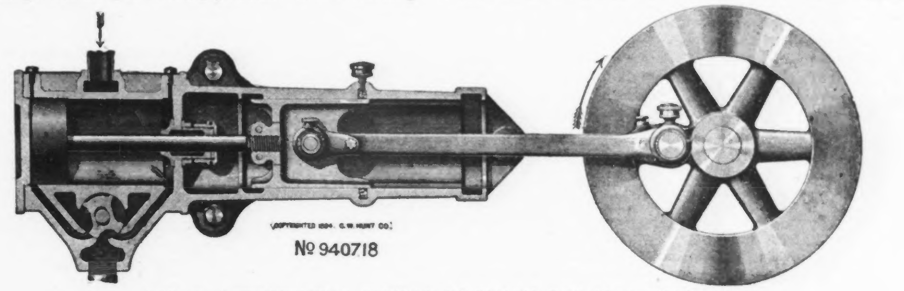


FIG. 2.—LONGITUDINAL SECTION OF ENGINE FOR COAL CRACKER.

ward, so that condensation water is swept out of the cylinder and ports at each stroke of the piston, and the cylinder condensation is materially reduced. The danger from accumulation of water in the cylinder and from frost is thus eliminated. The cross-head bearing on the slide is also made longer than the stroke of the piston, and this bearing is about four times the area generally used in commercial engines. By this arrangement, a central oil-well, packed with an elastic absorbent packing, is never uncovered, and the sliding surface is being constantly swabbed with oil.

The rolls are not adjustable in the frame; but are made of a proper diameter to break the coal to the size required. The delays and breakdowns adherent in adjustable frames are thus done away with. The points on the rolls are made of tool steel, with hardened ends, and these points are so shaped as to crack, and not crush, the coal. Fine coal passes through the breaker unchanged. Both the gearing and the rolls are entirely enclosed, each in a separate compartment, in a cast-iron frame; and the coal dust is thus prevented from entering the machinery or the room in which it is located. The gears are easily accessible, however, and run in a bath of oil. As the space available for this cracker is usually limited, the vertical distance between the feeding hopper and delivery spout is reduced to a minimum; and the breaker may be so placed below the hopper under the railway track that the coal may be fed directly from the car, and through the rolls to a conveyor leading to the storage bins. In hoisting coal from a vessel the cracker is usually put under the hopper into which the coal-buckets are dumped.

As this breaker may be subjected to great and sudden strains, the steel axles in the rolls are of large diameter and the frame is massive in construction; and the machine may be used to advantage in breaking other hard substances. The shipping weight is about 7,000 lbs. This coal cracker is placed upon the market by the C. W. Hunt Co., of 45 Broadway, New York city.

STREET CAR FENDERS MUST be placed upon all cars in San Francisco within 120 days, according to the final decision of the city supervisors, rendered Feb. 14. The companies can choose between the Craig, Hunter and Douglas fenders, but must select within 30 days.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post Office as Second-Class Matter.

Published every Thursday

at St. Paul Building, 220 Broadway, New York, by

THE ENGINEERING NEWS PUBLISHING COMPANY.

D. McN. STAUFFER, Vice-President, CHARLES WHITING BAKER, Secretary, . . . EDITORS.

GEO. H. FROST, President, F. P. BURT, Treasurer, . . . BUSINESS MANAGERS.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, A. B. GILBERT, ASSOCIATE EDITORS.

CHAS. W. REINHARDT, . . . CHIEF DRAFTSMAN

ALFRED E. KORNFELD, New York. F. A. PECKHAM, Chicago, ADVERTISING REPRESENTATIVES.

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

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

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

The consolidation of the Morison-Jewell Filtration Co. with the New York Filter Manufacturing Co., noted elsewhere in this issue, concludes a long legal struggle over the use of alum in mechanical filtration. This struggle has greatly hindered the development and extension of mechanical filtration, as nearly all the energies of these two companies were put into the fight and some of the other companies in the same field were indirectly affected by the litigation. Many cities and water companies suspended action on the adoption of water purification schemes, pending the outcome of the struggle, and others were influenced thereby to adopt slow sand filtration. Legal questions having been disposed of, it may be expected that the reorganized company will bend its energies to the development of the engineering and commercial phases of the business. While the conflict has been raging, slow sand filtration has been coming rapidly into greater prominence and new and important facts regarding the capabilities of mechanical filtration have been established by the Providence, Louisville and Lorain experiments. The value of pure water and the means of securing it are appreciated now as never before, so that altogether the improvement of many water supplies may be expected in the next few years. This will be accompanied by the saving of many lives and much ill-health and expense now caused by the use of impure water.

The provision of the specifications for the new East River Bridge towers and trusses* requiring all steel to be made by the acid open-hearth process was attacked in the courts last week, and an injunction was sought on behalf of a taxpayer restraining the Commission from limiting the bidding to makers of acid steel. The court, however, refused to issue the injunction, and in its opinion said:

> This action is commonly known as a taxpayer's action, and is authorized by the statute, but it can only be maintained to restrain threatened waste or injury to the estate, funds and property of the municipality, and it has been repeatedly held that it is necessary to allege and prove fraud, misconduct or bad faith on the part of the officers sought to be restrained. I have carefully examined the papers presented to me, and I am convinced that a difference of opinion only is shown.

We believe that engineers generally will approve the soundness of the court's decision. It matters not whether basic steel is as good as acid or not. The responsibility for selecting the material for a structure is rightly placed upon the engineer, and the courts should not and will not interfere with the proper exercise of his discretion. Mr. Buck and other engineers who hold that basic steel is not as reliable as acid, may be, and very likely are, mistaken. There are probably no engineers in any nation more systematic and microscopically thorough in their tests of material than the German engineers, and the German steel industry is almost wholly dependent on the basic process. Basic steel has been used so long now, both here and abroad, that its use is in no sense an experiment. Granting all this, however, the Commission and its engineer, who are responsible for this work, have a right to say what shall and shall not be used, and in the honest exercise of their discretion they should by no means be interfered with by the courts. An engineer may not be infallible in his decision of engineering questions; but we shall make no gain by setting a lawyer to review his decision.

*Engineering News, Feb. 17, 1898, p. 115.

In thus approving the decision above cited, we do not in any way mean to depreciate the duty of an engineer to keep himself informed on all matters of engineering progress, and to decide correctly all matters for which he is responsible. If basic steel is as good in every way or better in some respects than acid steel, it is the engineer's duty to know it and not to discriminate against it in his specifications. An engineer who relies on precedent merely for his guidance, and who fails to keep informed as to matters of engineering progress, fails to reach his highest usefulness to his clients.

For example, we may take the matter of specifications for rivets and riveting. At present, specifications generally call for all rivets to be machine driven where practicable, a specification easily fulfilled, since no bridge shop can afford hand-riveted work where machines can be used. On another page of this issue, however, we illustrate a pneumatic percussion riveter, which is already in extensive use on ship, bridge and boiler work. Will engineers accept this work as machine riveting in accordance with the specifications? Again there is the question of rivet material. Some engineers make no requirement as to the hurtful ingredients, sulphur and phosphorus, in rivet steel. Others limit the proportion to 0.06% of each. On the other hand, one well-known maker of rivets is offering material which runs as low as 0.005 to 0.015% phosphorus and 0.021% to 0.026% sulphur. If an engineer is designing a structure where high-grade material is a consideration, he should not set his requirements too low.

For another example, we may take the very common requirement that rivet holes shall be either drilled or else punched and then reamed. It was stated a few years ago that a shop equipped with gang drilling machines could drill structural steel as cheaply as it could be punched. This comparison was made, however, at a time when the single punch was in practically universal use. At the present time, however, some of the large bridge shops are equipped with multiple punching machines, through which a long plate or other piece can be run and all the holes in a line, as, for example, the holes for the stiffeners on a plate girder, are punched at a single stroke. These machines have so greatly reduced the cost of punching, we believe, that the requirement that holes shall be drilled, or even reamed, after punching means considerable extra cost. There are many places, of course, where this cost would be justified; but there are other places where the money had better either be saved or else invested in increasing the section of the various members.

In our discussion of the "Denver Water Rate Case and Its Lessons," in our issue of last week, we asked, "to what extent can the decision be considered as permanent?" We stated that either of three cities whose water rates entered into the average made up by the court as a basis for the new Denver rates might change its rates at any time. The papers now announce that the Chicago city council has revised the rates charged in that city, cutting them in half on at least one fixture, although it is estimated that the net result will be an increase of $200,000 in the yearly revenue of the water department. We did not expect so prompt a fulfilment of our prophecy. We understand that an appeal is being taken in the Denver case, so there is a possibility that this phase of it may yet be brought under review. Justice to both sides demands that the absurd idea of attempting to regulate the rates by an average be abandoned, and that the city and its inhabitants should pay, and the company receive, a reasonable compensation for services rendered, without any regard to the rates in other cities where the conditions are utterly different.

It is not many weeks ago that our esteemed contemporary, "The Engineer," of London, was enlightening its readers upon the threadbare old subject of riveted vs. pin-connections for bridges, and explaining to them that the reason why American engineers always preferred pin-connections to rivets was because they "found it cheaper to build their bridges on the pin principle."

This sermon by our contemporary, however, seems to have fallen on stony ground, if we may judge from a letter which it prints in its correspondence columns in its issue of Feb. 11. We quote it in full as follows:

TUBES IN SHEAR.

> Sir: I have a pin bridge to put up; it is a small affair, only 25-ft. span, for foot passengers. It is necessary that it should be extremely light. I am going to make the pins of steel tube—hydraulic tube, in fact. This will give me plenty of surface, which is, I take it, an essential element in shearing strength. However, I can find no data on the subject, or information of any kind, and as I begin to think that no experiments on the subject have ever been made, I venture to ask through your columns for the results of other readers' experience. I have an idea that the late Rowland Mason Ordish used tubular pins in the Buda Pesth or some other bridge, but I am not certain.
>
> Isleworth, Feb. 9. P. Warren.

A 25-ft. span bridge with pin-connections! And plenty of surface is an essential element in shearing strength, he takes it! We cannot refrain from wondering if Mr. P. Warren is thinking of conducting an original investigation into the shearing strength of hollow pins to guide him in his design of a 25-ft. span foot bridge. If there is much bridge engineering of this sort in England, "The Engineer" may well continue its crusade against pin-connections, and it can do so more intelligently if it will first study the elements of American practice in bridge construction at the present day.

A sweeping ordinance designed to prevent the electrolysis of water mains and other underground conduits has been unanimously approved by a committee of the city council of Atlanta, Ga. It is so brief and interesting that we give it in full, as follows:

> Be it ordained by the mayor and general council of the city of Atlanta, and it is hereby ordained by the authority of the same, that it shall be the duty of all persons or companies using or employing electrical currents in the streets of the said city by or before July 1, 1898, to provide and put in use such means and appliances as shall well and effectually retain said currents on their own wires, tracks or other works and keep them off the gas pipes, cables or other structures in said streets and to repair and renew said means and appliances or from time to time change and improve the same as may be necessary to accomplish said purpose, all at his or their charges and expense and at his or their own risk, selecting and adopting such means and appliances as shall effectually accomplish said object and maintain and keep the same effectual as aforesaid. Any person or company violating this ordinance shall be subject to a fine of $100 for each and for each street where the same may be violated, and in order to a conviction under this ordinance it shall not be necessary to show that the entire electrical current imposed on the structures of the city or other persons escapes from or comes from the power house or works of the party charged aforesaid, but it shall be sufficient for a conviction if a company or party by failing to restrain its currents materially contributes to the result complained of as aforesaid.
>
> Sec. 2. Be it further ordained by the authority aforesaid that neither the collection of any penalty for violating section one above or any prosecution for the same shall have the effect to take away or abridge the right of the city or any other party or company to damages arising from the trespass done to the property or persons by such current being permitted to escape from the structures of the party generating the current or currents, and in case of damage to property or the city, that the same be demanded and collected through the proper channels, and on failure to pay, that the same be sued for in any court having jurisdiction.
>
> Sec. 3. Be it further ordained by the authority aforesaid that all ordinances and parts of ordinances in conflict with this ordinance be and they are repealed.

The two most notable points about the ordinance are: (1) That it absolutely requires all electrical companies in the city to provide for the return of their currents to the power-house in such a manner that it will be kept off the underground pipes, etc., named; and (2) that the means by which this shall be effected are left entirely to the electric companies. The latter feature of the ordinance is directly contrary to the one passed at Richmond, Va., and published in full in our issue of Feb. 27, 1896. The Richmond ordinance stipulated in detail how the current should be returned. It required that the rails should be bonded by welding or by copper wires; that a copper wire should be laid between the rails the whole length of the track and connected with the latter every 300 ft.; and that there should be a metallic return of old rails or other suitable material. There are advantages in both the Atlanta and the Richmond plans. The Atlanta ordinance leaves the companies perfectly free to choose any method they may see fit, which might be a great advantage. The Richmond plan relieves the companies of responsibility. If they follow this or any other ordinance with similarly definite provisions the city can require no more, whatever the result. Of course the city might pass a new ordinance, laying down a new plan, but it could not do this with good grace after failing once. On the other hand, it is sometimes better for a city to lay down definite rules, if it is sure of their efficiency, and insist on their execution, instead of giving a company a chance to adopt makeshifts, if it wishes. To be sure, the Atlanta authorities can declare, over and over, that the provisions of this ordinance have not been carried out and demand new methods, but such a demand would probably result in litigation. On the whole, however, the Atlanta plan has very much to commend it. If the various companies concerned will meet its provisions in good faith, and we are aware of no reason why they should not, satisfactory results will doubtless follow.

According to the review published in this issue by Prof. Van Ornum, the prevailing status of the laws governing the appointment or election of County Surveyors and Surveyors General in the United States, show a lamentable adherence to out-of-date and inefficient methods. These laws are evidently a survival of the days of small things; when the low value of land made the accuracy of work less important, and when roads and other public improvements, worthy of the name, did not exist. These laws sadly need revision; and it is an encouraging sign that within the last six years some few of the states have made new laws of a more business-like character, which, in some measure, at least, recognize the changed conditions and the public necessity and advantage of having engineering work done by engineers. But in this day of better methods the laws of more than half of the states still call for magnetic surveys and "two-pole" chain surveys; and only a very few of these states provide for any check upon these methods by the establishment of a true meridian and standards for comparing chains or tapes. Apparently, any old instrument available may be employed, without test or record of its idiosyncracies; yet, in some courts, the surveys of the County Surveyor, or those made by the United States authorities, are alone legal evidence.

At the present time the question of better roads is being loudly discussed; and while many states and communities hesitate to expend the amounts necessary, the value of the proposed improvement is very generally admitted. But the road laws that have been already passed are, with a few exceptions, hastily framed, and the result is little or no improvement in that direction. The location and building of common highways, on modern lines, demand a special training and experience that comparatively few county surveyors possess; and, as a rule, the state laws calling for engineers to superintend work of this character, do not specify the County Surveyor as the proper official in charge. Yet, this class of work properly belongs to that office; and if the incumbent were selected for general fitness for the duties to be performed, no one could better shoulder the responsibility involved for all work within his county. California, Washington, Ohio, Montana and New Mexico, by laws enacted within the last six years, recognize the fitness of the county surveyor for this duty, and practically require him to act whenever and wherever the services of an engineer are required within the county and outside of large cities having their own engineer. But engineering work requires for its proper performance engineering education and experience, and herein the laws relating to county surveyors are very weak.

In all but four of the states and territories this official is selected by popular vote; and it is exceptional where the law demands any other test of fitness for office than the ability as a politician to solicit and secure votes. So far as fitness is concerned, and so long as politics prevail, this is about as safe as an appointment by county commissioners or judges. But the law can and should fix some standard of training and experience to be applied to the candidate; and in a few states this is done. The chief trouble in obtaining proper men to fill the office of county surveyor seems to be due to several ruling causes. The compensation allowed is generally too small to attract engineers and surveyors of real merit; and the engineering responsibility of this officer is generally so limited, and the works of importance placed under his charge are so few that the position becomes undesirable to men of experience and ability. In both states and counties, the fact has yet to be fully appreciated that whatever work of importance is to be done, it is true public economy to place this work in the hands of the most capable man; and to properly pay him for standing between them and possible bad work and wasted funds. With the best intentions in the world, the inexperienced man will cost the public, in some form, much more money than is represented by the difference between his salary and the compensation of an efficient engineer. And this law holds good in the case of the location and building of roads, in the purchase of county bridges and even in the minor engineering work of the county; to say nothing of the importance of accurate surveys by modern methods of precision, and the needless and costly litigation which results from bad or careless work.

THE WATER SUPPLY CRISIS AT PHILADELPHIA.

There are many disgraceful episodes in the municipal history of Philadelphia, but the plan which the councils of that city are endeavoring to carry into effect, of turning over the water supply of the city to a private corporation, surpasses in its corruption the worst that the past can show. The press of the city is well-nigh unanimous in its condemnation of the scheme; the people have pronounced against it at the polls; but the parties who are seeking to get control of the city's water supply and the councils whose members are sworn to protect the public interests seem absolutely indifferent to public opinion.

More than twenty years ago Philadelphia, during the Centennial, acquired a national reputation as a hotbed of typhoid fever. It has continued for more than a decade to have an excessive amount of the disease, and very recently it has had even more than its usual large number. The sewage-polluted water supply is rightly held responsible for this. Besides being always unfit for drinking, the Philadelphia water is frequently unsuitable for bathing or laundry purposes.

Numerous investigations have been made looking to a supply of pure water to be obtained by the city itself; but those which promised to meet the city's needs have in every case been thwarted by private interests having real or alleged water rights to sell or desirous of making huge profits by contracts for supplying the city with filtered water. On the other hand, public opinion has been so strongly against turning over any part of the water supply system to a private corporation that every scheme to that end—and the crop has been perennnial—has been defeated through the industry and perseverance of some of the city's public spirited citizens. In some cases those who desired to secure the water-works for their own profit have had them almost within their grasp; but the endeavors of those who sought to defend the city's interests have eventually been victorious.

But those who attempt to gain control of a city's public works for their own profit can afford frequent defeat if they win success in the end. They have enough at stake to make it worth their while to try again and again, while those who are actuated only by their public spirit eventually grow weary, especially when those who are sworn to protect the city's interests appear far more anxious to aid the promoters who are in search of plums.

Those who sought to control Philadelphia's water supply have not been discouraged by past defeats; instead they sought new means to encompass their ends; and they found their opportunity in the foul condition of the present water supply. The course adopted and most consistently followed for three years has been for the city council to refuse all appropriations for the extension and improvement of the works, thus deliberately crippling the water plant, as the gas plant was crippled.

The facts show so plainly that no one can doubt them, that this was done intentionally and deliberately, with the direct purpose of putting the water-works in such a condition that public opinion would sanction turning them over to a private corporation, just as the city's gas plant was crippled for a similar purpose. Both the water and gas works have yielded handsome net revenues to the city, and had these been expended for the maintenance and betterment of the works, both the water and gas works might be to-day supplying all the city's needs; but, instead, these revenues were used for other city expenses; and the urgent appeals of the city's own officials that the water and gas supply should be given the funds absolutely necessary to put them in proper condition were unheeded.

During the past year no fewer than twelve ordinances for improving the water supply have been introduced in the city councils. Most of these ordinances have authorized long-term contracts for water, generally filtered water, delivered to the city, under a great diversity of plans both in the method of supply and of payment therefor. Last summer one of the plans was reported favorably by a committee of councils, but so much opposition was manifested by the public that the same committee immediately reported favorably all the other ordinances, a farce that caused much amusement.

Last November the people of Philadelphia voted in favor of a $12,000,000 loan, which included $3,700,000 for the improvement and extension of the water-works, most of which was designed to be used for a filtration plant. Notwithstanding this approval, at the polls, this loan is being held up in councils, for if it should be effected the long-fought battle by the syndicate for a profitable water contract would probably be doomed. So regardless are the councils for the various interests of the city, in their zeal to give a water contract to a private company, that they are holding up the items for a great variety of other improvements, besides those connected with the water-works, including sewers, bridges, streets and schools. In order to force the issue an attempt was made to pass the loan bill with most of the items except the water appropriation stricken out, but this, too, failed.

Coincident with the failure of the loan bill in the common council, the select council passed several sections of an ordinance providing for a 50-year contract with the Schuylkill Valley Water Co., involving yearly payments of about $1,500,000 to the company by the city. In return for this the company would supply 400,000,000 gallons per day of filtered water from the Schuylkill River, and 75,000,000 gallons from the Delaware River. It would also provide 18,000,000,000 gallons of storage in the Schuylkill River above the city. The water would be delivered to the present pumping stations, but the city would have to pump it, as as present. At the end of the fifty years the plant would be turned over to the city without further payment.

On Monday and Tuesday of the present week the Select Council passed the ordinance on its second reading, the previous question being called for the first time, it is said, in twenty years. It also consolidated the 21 sections of the ordinance into three, to facilitate its passage through the Common Council. At nine o'clock Wednesday morning the Select Council was to meet again, when it was expected that the bill would pass the third reading and be sent to the Common Council, a special session of which had been called for ten o'clock. Mayor Warwick has expressed himself strongly against turning any part of the water-works over to private control, and has said that he will veto the ordinance, if passed. The majority thus far shown in the Select Council is exactly sufficient to pass the ordinance over the Mayor's veto. What the vote of the Common Council will show remains to be seen, but it is now expected that the promoters have made sure of the necessary here also. The most influential portion of the public press of the city is outspoken against the measure. Speaking of certain reasons urged in favor of the bill, the "Times" said on Feb. 22:

If any private corporation ever gets control of the water service of this city it will not be upon any such argument as that. The actual reasons will be of a private and confidential character, known only to the agents and lobbyists of the company and such members of the councils as can be purchased.

On the following day the "North American" said:

A simple arithmetical calculation will show that by the time the 50-year contract had expired the city would have paid to the Schuylkill Valley Water Co. the sum of $73,537,150, and for that sum it would have received in the interim a supply of water from the same source which it now utilizes gratuitously and in addition a plant which by that time would probably have survived its usefulness. Is there any disinterested man of common sense who will say that such an arrangement is one which would be profitable to the city to enter upon? There are other objections to the scheme, many of them, but the enormous disproportion between what the city is to pay and what it is to get is alone sufficient to condemn it.

On the same day the "Public Ledger," one of the strongest and most respectable papers in Philadelphia, said:

So eager are Select Councilmen to make this bargain, although it is clearly in the interest of a private coroporation and against the interests of the city, that they have called a special meeting for to-morrow morning that they may anticipate the action of Common Council in passing the loan providing for an improvement of the water supply. The main purpose now is to defeat the loan, for they recognize that if the city shall once begin work on filtration there will be no choice for speculators to sell water to the municipalty. They cannot hope to pass the ordinance providing for a contract with the Schuylkill Valley Water Co., for Mayor Warwick is sure to veto it, and Select Council cannot muster enough votes to pass it over his veto. But by passing the Schuylkill Valley Water Co.'s bill they can halt the loan ordinance or think they can, and thus secure such delay as to help them in a second effort with the new City Councils. The delay may mean the deaths of a few score of people from typhoid fever, but that appears to be a matter of little consequence to the majority of Select Councilmen, who will do anything to serve a corporation.

Following these two utterances, on Feb. 24 the "Press," in connection with the other strong words of condemnation, stated:

Never was venal job so palpable in its venality as this. Its supporters have no motive for supporting the ordinance but cold cash. This is, however, sufficient for many of them, and they appear to have no sense of shame about it.

It is pleasant to turn from a contemplation of the attitude of Philadelphia's legislative assemblies, to the official in responsible charge of its water supply, Mr. John C. Trautwine, Jr., Assoc. Am. Soc. C. E., Chief of the Bureau of Water. From his official report for the year 1897 to Mr. Thos. M. Thompson, Director of Public Works, we take the following vigorous extract:

The water service of this city is in a critical condition. Between continued starvation on the one hand and enormously increasing waste on the other, it is made to appear, as stated in your report of Oct. 7, that "we are compelled to negotiate with corporations and individuals to secure for the citizens of Philadelphia a pure and abundant supply of water."

As a matter of fact, the city holds in her own hands the key to the solution of her water problem. As stated in my report to you of Sept. 25 last, "the city has at its doors an ample supply of water for the freest possible use of all our citizens, for at least a generation or two to come, and our present machinery, with the possible exception of our distribution system, will be ample for handling it for years to come."

All we need is means for preventing waste and means for filtering the water. Given these and the present supply is all that can be desired, both as to quality and as to quantity.

Both of these objects can be secured at a cost not exceeding, perhaps, $10,000,000 total, and the needed improvement can be made gradually, defraying the expense out of the surplus earnings of this bureau, which now amount to about $1,000,000 annually. To launch out into contracts with private corporations, binding the city to the annual payment of millions of dollars for 50 years for facilities which the city does not want, would, therefore, appear absolutely inexcusable.

Mr. Trautwine gives a table of water consumption by years, showing that the per capita consumption has increased from 36 gallons in 1860 to the enormous figure of 215 gallons in 1897. He then makes the statement already mentioned above, that councils have for three years refused all appropriations for improvements, although the water department "has been earning annually for the city about $1,000,000 above its expenses." He next discusses the question of waste and its most effective remedy, the meter system, arguing truly that this would injure no one, would cut in two the cost of installing and operating filters, and would postpone enlargements of the plant. He refers to the fact that councils have not even followed his suggestion of two years ago that an ordinance be passed providing for the metering of all large consumers, the metering of residences upon application of the owners, or, in case of waste, without their consent. He places restriction of waste before purification, "because it belongs there," adding that "no competent manufacturer would apply costly processes of improvement to needlessly wasted material."

Mr. Trautwine sweepingly condemns the various water contracts, ordinances for which are pending in councils, as follows:

. . . As a whole they are mischievous as diverting effort from the one thing needful. The proposition of the Philadelphia Sanitation Co., and the Electric Rectifying & Refining Co. looking to the purification of the present supplies should be unhesitatingly condemned, because they commit the city to the wholesale adoption of untried and almost unknown methods. The remaining propositions involve a change in the source of supply. Most of them involve heavy expenditures, for which there is no occasion.

Speaking of the proposition of the Schuylkill Valley Water Co., now so prominently before councils, as outlined above, Mr. Trautwine says:

This scheme is equally unnecessary with that of the Philadelphia Water Supply Co., and scarcely less costly, except that at the end of 50 years the works (which then will be of but little, if any, value) become city property without payment. In my report of Sept. 25, I called your attention to many mischievous provisions in the ordinance submitted by this company; and in my report of Dec. 29, after a careful study of some of the plans submitted, I mentioned the following objections to the scheme from an engineering standpoint:

The damages involved in the flooding of the adjacent country by the proposed dams would probably be found prohibitory by the company. But, even if the dams were built, the 18,000,000,000 gallons storage provided would be insufficient to sustain the proposed draft of 400,000,000 gallons per day (a draft which at our present rate of increase will be reached by 1915), while the cross-sections of the proposed pools are so shallow that, even during normal years, the drawing down of their levels in summer would leave them in a most objectionable condition, wide stretches of previously submerged country being exposed to the sun or covered with a few inches of water. The defects of the proposed storage system would alone suffice to condemn the scheme, even if the city required anything of the sort.

The ruinous and dangerous condition to which parts of the works are being reduced by the failure of the councils to make appropriations is stated as follows:

At Fairmount, one of the two large wheel-houses has been for years in a condition so disgraceful that, for decency's sake, we have been obliged to keep it closed to the public, and the engines are rusting from the rain which percolates through the roof; while the forebay, which, unfortunately, we cannot hide, is equally an eyesore. During the year it attracted the attention of the health authorities.

At Spring Garden, where more water is pumped than at all the other stations combined, the forebay is in scarcely more presentable condition than at Fairmount, and our largest and best engines are wasting coal for want of proper boiler capacity.

At Belmont we are forced to pump without intermission, whatever may be the state of the river; and yet the boiler service is altogether insufficient and in pitiable condition, liable to collapse that will throw the entire system out of service and deprive the district of water; and the largest, newest and best engine is protected only by a rude house of boards, erected over it in 1894-5 by employees of the Bureau in default of means to provide a proper house, for which plans were prepared in our drafting-room years ago.

At Queen Lane (our newest and finest station), the four large new engines have all been fractured, and further damage to them is hourly threatened by want of means to relay the suction mains, which bring the water from the river to the pumps; from the pumps all the water goes to the reservoir through a single pumping main, seriously increasing the pressure upon both main and pumps and endangering the whole system; and, the station being still unprovided with proper means for storing and handling coal (although designs for a coal-handling system were designed years ago), the coal used has to be hauled by carts, adding over $7,000 per year to the cost of pumpage.

At Roxborough the boilers are in scarcely less deplorable condition than those at Belmont, while the engines are in much worse condition. At this station it is all we can do to keep pace with the consumption, so that, while the relining of the new reservoir was completed months ago, we have not yet been able to fill it.

Belmont and Roxborough high-service stations are provided each with an old engine, which had formerly done duty elsewhere, and which must be kept going night and day, year in and year out, with no chance for repairs. An accident to this single engine would throw the system out of service and deprive the district of water.

What the outcome will be of the present situation in Philadelphia, we shall not attempt to phophecy; but we have deemed it proper to set forth the facts in detail here, since they are of interest and importance to a far larger and wider circle than the citizens of Philadelphia alone.

Every promoter who seeks to wrest from a city the ownership and control of its public franchises is already quoting the transfer of the Philadelphia gas works to a corporation, as an example to be followed; and we may be sure that if Philadelphia's water supply shall also go into a private corporation's hands, that also will be quoted as a precedent by the enemies of municipal ownership. We have deemed it proper, therefore, that the story of the means by which this transfer is to be effected, if at all, shall be placed on permanent record in our columns. Surely no honest man can say that the course of Philadelphia's councilmen, or the course of those who are seeking a contract worth millions of dollars at their hands, is an example worthy to be followed.

LETTERS TO THE EDITOR.

Cost of Concrete in the United States.—Correction.

Sir: I will respectfully call your attention to an error made in two places in the table by Mr. T. Jenkins Hains giving the cost of concrete done by the United States, in Engineering News of Feb. 17, p. 109.

For the work on Rough River, Ky., the concrete was not made of natural cement, but of the best German Portland cement, the average cost of which, delivered on the work, was $3.15 per bbl., making the cost of cement per cubic yard of concrete, $4.56.

Very respectfully Wm. M. Hall.

United States Engineer Office, Louisville, Ky.,
Feb. 23, 1898.

Diagram for Determining the Power of Waterfalls.

Sir: I send you enclosed a copy of a diagram for the graphical determination of the horse-power of any given water fall, being a simple form for the graphical reading off of the HP. from the formula, . . HP. = H. Q. D. E. ÷ 500, in which:

H = The effective head on the wheel in feet.
Q = The quantity of water flowing in cu. ft. per second.
D = Weight of water per cu. ft.
E = The percentage of efficiency of the wheel.

For D = 62.4 lbs. per cu. ft.; HP. = 0.1134 H. Q. E.

The inclined lines radiating from the zero at the lower left corner are of three different kinds: Those running to the upper edge of the diagram represent the quantity of water; those running to the right side of the diagram represent the different percentages of efficiency, except the one line which crosses the margin between 85% and 90%, which is a conversion line to transform the resulting value of the horse-power into such linear values as to permit them to be represented by the graduations along the base of the diagram. This line is drawn at an angle with the vertical lines, whose tangent $t = 1/2\ (0.1134)\ 75.v/h$, where v and h are the numerical values of the vertical scale of head and the horizontal scale of quantity;

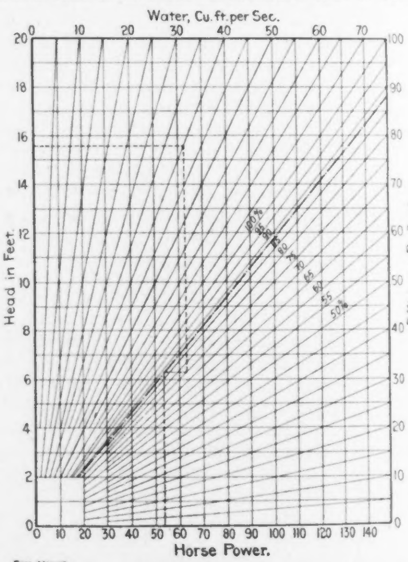


Diagram for Determining Horse-Power of Water-Wheels and Water-Falls.

Example: Head = 15.6 ft. Quantity = 40 cu. ft. per sec. Efficiency = 75%. Then Horse-power = 53.2.

the 1/2 being introduced in this case to make the HP. units along the base of the diagram one-half the value of the quantity units along the top edge of the diagram. To use the diagram: Start with the value of the head on the left margin, pass horizontally to the radiating line representing the given quantity, thence pass vertically down to the proper efficiency line, thence pass horizontally to the inclined conversion line, thence vertically down to the horse power line along the base of the diagram, where the proper value may be read off. With heads or quantities in excess of the maximum value of the diagram, the scales may be assumed changed to ten times that graduated and the resulting horse-power read off to a scale either ten or one hundred times that graduated, according to whether one or both the argument scales have been amplified. One or two other arrangements of the lines indicating respectively the heads, quantity and efficiency **have been used but the one here given is offered where compactness is the prime requisite.**

Respectfully, Olin H. Landreth,

Union College Engineering School, Schenectady, N. Y., Dec. 31, 1897.

(We have redrawn the diagram with only the principal lines, to make its construction clear to our readers. Those who desire will find no difficulty in constructing a diagram on this plan on cross-section paper to such a scale as their needs may require.—Ed.)

The Thrust of Coal Against the Sides of Coal Bins.

Sir: In computing the thrust of any granular mass, as sand, coal, grain, loose rock, etc., against the side of a retaining wall, coal bin or other restraining surface, the friction exerted against the surface by the granular mass, due to its settling or to relative movement (as when a retaining wall moves over at the top slightly) should be carefully considered. From ignoring this friction, Mr. Benjamin Baker, in his book on "The Actual Lateral Pressure of Earthwork," often found the theoretical thrust, as computed by the formula used by him, to be double that actually exerted.

In "Van Nostrand's Engineering Magazine," for February, 1882, I analyzed many of the experiments recorded by Mr. Baker, using a formula that included the wall friction, and was gratified to find that theory and experiment agreed fairly well.

In Van Nostrand's "Science Series," No. 3, 2d ed., p. 141, will be found a resume of the results for several of the above-mentioned experiments, with others subsequently discussed. Those pertaining to vertical retaining walls having a rectangular cross section and earth level at top are included in the following table:

No.	h ft.	t ft.	$\frac{e}{w}$	φ	q	q_0
1	4,000	1,000	2.20	39° 48′	−0.06	−0.79
2	10.000	1.920	0.955	36° 53′	+0.04	−0.58
3	1.000	0.350	3.18	33° 42′	−0.03	−0.74
4	0.558	0.159	3.29	35° 00′	−0.02	−1.33
5	0.367	0.100	1.25	33° 42′	+0.16	−0.30

h = height of wall in feet.

t = thickness of wall in feet.

$\frac{e}{w}$ = ratio of weight per cu. ft. of earth to weight per cu. ft. of wall.

φ = angle of repose of earth.

q = ratio of the distance from center of pressure on the plane of the base of the wall to the outer toe, to the thickness t, using theory that rationally includes the friction of the earth against the wall.

q_0 = do., not including friction.

q_0 was found by using the Rankine formula for the horizontal earth thrust,

$$E = \frac{1 - \sin\varphi}{1 + \sin\varphi} \frac{e h^2}{2} \qquad (1)$$

To find q the formula used was:

$$E = \left(\frac{\cos\varphi}{n + 1}\right)^2 \frac{e h^2}{2 \cos\varphi^1} \qquad (2)$$

where,

$$n = \sqrt{\frac{\sin(\varphi + \varphi^1) \sin\varphi}{\cos\varphi^1}} \qquad (3)$$

All three formulas refer only to earth level at top. In (2) and (3), φ^1 = angle of friction of earth on wall and when $\varphi^1 > \varphi$ it must be replaced by φ. The thrust here is supposed to make an angle below the normal to the back of the wall = φ^1 when $\varphi^1 < \varphi$, otherwise angle φ and its amount. as computed by (2) is laid off parallel to this direction at a point one-third the height of the wall above the base. When φ is replaced by φ, (2) becomes,

$$E = \frac{\cos\varphi}{2(1 + \sin\varphi\sqrt{2})^2} e h^2 \qquad (4)$$

These and other formulas are demonstrated in Van Nostrand's "Science Series," No. 3, also two independent and simple graphical methods for ascertaining E for any earth contour.

A brief description of the walls above will now be given. No. 1 (by Baker) was of pitch pine blocks, sustaining a mass of macadam screenings. The top of earth was 0.25 ft. below top of wall. φ^1 was assumed at 22°, angle of friction of timber on stone. No. 2 (by Lieut. Hope) was built of bricks laid in wet sand. It was 20 ft. long and backed by earth. $\varphi^1 = \varphi$ in this experiment. No. 3 (by Trautwine) was of wood, backed by sand. φ^1 assumed = 22°, as in No. 1. Trautwine only gives the ratio of t to b. No. 4 (by Curie) was a wooden wall coated on the back with sand. ∴ $\varphi^1 = \varphi$. The wall was subject to thrust from sand. No. 5 (by Leygue) was of plaster, backed by sand. The angle $\varphi^1 = \varphi$.

In the table, q is taken positive when the resultant on the base strikes within the base of the wall, otherwise negative. It is seen from the q column that the resultant passes within from 0.02 t to 0.16 t from the outer toe when formula (2) is used, so that the results by this method (which includes the wall friction) are fairly good for practice. By the common formula (1), the friction between the earth and wall is entirely neglected, as the thrust is assumed to be horizontal, and it is seen from column q_0 that the resultant on the plane of the base strikes it outside of the wall at distances ranging from 0.58 t to 1.33 t from the outer toe.

This, it seems to me, utterly condemns this formula (1) for practice. Has not the time come for its permanent retirement?

I challenge its advocates to produce a single experiment on a retaining wall with which it agrees, even approximately.

The formula is undoubtedly correct for the horizontal pressure on a vertical plane in the interior of an unlimited mass of earth with a horizontal surface, and also in a case I shall presently give, but for surfaces against which the earth rubs in settling or when relative movement is induced in any way, it does not generally apply.

Neither will it suffice to multiply E as given by (1) by the coefficient of friction of earth on wall and combine this force, acting vertically downwards at the back of the wall, with E, to get the total thrust on the wall; for it can be shown that such a thrust does not correspond to any plane of rupture.

The formulas (2) and (3) are by no means all that one would wish with which to solve practical problems, but they come nearer fitting experiments than any formulas that have been devised on rational lines, and as such they can be made to do good service. The French authors, as a rule, have long given the direction of the thrust as outlined above.

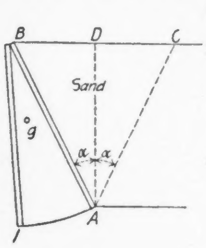


Fig. 1.

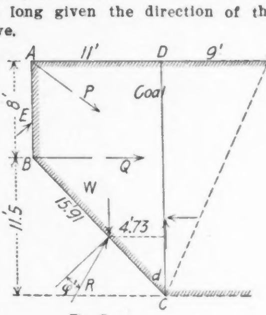


Fig. 2.

Three experiments by Curie will now be described. In the first two, the retaining wall I B A (Fig. 1) was a wooden frame, whose center of gravity g was determined experimentally. It weighed 53 kilograms. The board A B was 1 meter square and it supported the sand filling B A C weighing 1,555 kg. per cu. m. In the first experiment, A B was inclined to the vertical, at an angle B A D = 27° 30′, $\varphi = \varphi^1$ = 35°, and the wall was at the limit of stability when A I = 0.45 m. Now, I have demonstrated analytically in "Van Nostrand's Magazine," Feb., '82, and graphically in "Van Nostrand's Science Series No. 3, 2d ed.," p. 50, that the thrust on plane A D can not be less than given by formula (1), and that it is exerted horizontally; for since the plane A B is inclined to the vertical, the same amount with the plane of rupture A C (D A C = 45 − $\frac{\varphi}{2}$ = 27° 30′), if any less thrust is used on plane A D (especially if it is inclined downwards), the resultant thrust on A B found by combining this thrust with the weight of the prism of earth B A D will be found to make a greater angle with the normal to A B than $\varphi^1 = \varphi$, so that equilibrium is impossible.

The same principle holds when the face of the wall lies below A B, as in the next experiment.

Therefore computing the thrust on A B by (1) and combining this with the weight of earth B A D and frame, it is found that the resultant strikes the base A I, 0.15 of its width from I between I and A.

In the next experiment, the angle B A D was 55° and $\varphi = \varphi^1$ = 33° 30′. Pursuing the same plan, it is found that the resultant strikes within the base 0.02 A I from I, or practically through I. The third experiment was upon a smaller retaining board, with the earth surface horizontal as before. Here A B = 0.2 metre, B A D = 55° as in the last experiment, $\varphi = \varphi^1$ = 35°, e = 1450 kg per cu. m., and the weight of retaining frame = 2.27 kg. Computing the thrust on A D by (1) and combining with weight of sand B A D and frame, the resultant is found to pass 0.06 base inside of I. The last two experiments show a very close agreement to the theory proposed.

The attempt will now be made to find the thrusts against the sides of the coal bin described in your issue of Sept. 23, 1897. Thus let Fig. 2 represent a part of the cross section of the coal bin. To find the thrust E on a linear foot of the face A B, the angle of friction φ^1 of coal on iron must be known. Not having any value at hand, put for purposes of illustration. φ^1 = 15°; also φ = 30°, b = A B = 8 ft., e = 58 and find n = 0.605 from (3) and E = 559 lbs. from (2). This thrust acts at ⅓ A B = 2.67 ft. above B and is inclined below the normal at 15°.

Next, from analogy to the method used in the last three experiments discussed above, compute the horizontal thrust on the vertical plane C D by (1), placing C D = h = 19.5 and find E_0 = 3676 lbs.

The weight of the prism of coal A B C D = W = ½ (8 + 19.5) × 11 × 58 = 8,773 pounds, and it acts along a vertical, passing 4.73 ft. to the left of C.

The mass of coal A B C D is held in equilibrium by four forces: the resistance of the wall A B = E (equal and opposed to the coal thrust on A B and acting at 2.67 ft. above B), the weight W acting along a vertical 4.73 to left of C, the thrust E_0 acting horizontally to the left, 3.5 ft. above C and the reaction R of the side of the bin B C. On combining E, W and E_0, either graphically or analytically, it is found that R = 9180 lbs., and it acts on B C, 6.83 ft. above C, giving a normal component = 8229 lbs. inclined 26° 19′ to R.

As this angle is greater than φ^1 = 15°, it is seen that the resultant thrust of coal on B C makes a greater angle with B C than the coefficient of friction φ^1 of coal on wall; therefore equilibrium is impossible by an extension of Rankine's principle stated by him as follows:

> It is necessary to the stability of a granular mass, that the direction of the pressure between the portions into which it is divided by any plane should not, at any point, make with the normal to that plane an angle exceeding the angle of repose.

If, in reality, for coal on iron, $\varphi^1 = \varphi$, the above method would suffice. If, however, φ^1 is less than 26° 19′, then for stability, the resultant R on B C must be assumed to make the angle φ^1 (taken here as 15°) with the normal to B C and its value found. Two approximate methods will now be indicated.

In the first, ignoring the friction along A B, the plane of rupture C I was found by a graphical method, so that the mass of coal A B C I, in its tendency to slide down C I would exert the thrust R on B C inclined to the normal to B C at an angle of 15°. R was found to be 8700 lbs. An inspection of the diagram shows that Rankine's criterion above for stability is everywhere fulfilled. The distance D I is about 9 ft. The method of construction is given in "Science Series" No. 3, p. 40. On page 96, the derivative of (9) with respect to l, gives for the intensity of the pressure of a granular mass at depth b, on the surface B C inclined at an angle α with the vertical C D (Fig. 2 above) and to its left, R making again the angle φ^1 with the normal to B C.

$$p = \left[\frac{\cos(\varphi - \alpha)}{1 + n}\right]^2 \frac{e h}{\cos\alpha \cos(\varphi^1 + \alpha)}$$

where,

$$n = \sqrt{\frac{\sin(\varphi + \varphi^1) \sin\varphi}{\cos(\varphi^1 + \alpha) \cos\alpha}}$$

for earth level at top and the plane B C extending to plane D A produced and the coal resting on its whole length, so that wall A B is this time eliminated entirely. This furnishes a second approximate method for estimating the thrust.

The formula gives for the intensity parallel to R at C (h = 19.5, e = 58, φ = 30°, φ^1 = 15°, α = 43° 44′) p = 732 lbs. per sq. ft.

The pressure at B for such a supposed mass is $\frac{8}{19.5}$ p = 300, so that the resultant pressure on B C or R = ½ (301 + 732) × 15.9 = 8212 lbs., its normal component being 7932 lbs. The distribution of pressure on B C by the law of the trapezoid assumed here, is doubtless inexact when the wall A B is in place, for as the horizontal component of E (on A B) is less than the horizontal thrust on some vertical plane, of the same depth, to its right, the difference, which is directed to the left, must be ultimately carried to the wall B C and thus cause an irregular distribution of stress on B C. Similarly, the weight of coal held up by friction on A B modifies the result.

On this account it seems safer to take R = 8700 lbs., as given by the preceding construction, which supposes the plane A B to be perfectly smooth, and thus doubtless errs in excess. Assuming the law of the trapezoid for want of a better, R is found to act 6.8 ft. above C. The normal component of R = 8430 lbs. and the normal intensities at B and C are 308 and 753 lbs. per sq. ft.

The thrust on the vertical plane C D is no longer horizontal; its horizontal component, directed to the left, E_1 = 4500 lbs., and its vertical component, directed upwards = 1313 lbs.

To find the stresses P and Q in the tie rods, the method suggested by Prof. Church (Eng. News Nov. 4, 1897) is most convenient. As the bents are 17 ft. apart,

E (on 17 ft. of A B) = 558.6 × 17 = 9,496 lbs.

W (on 17 ft.) = 8773 × 17 = 149,141 lbs.

E_1 (on 17 ft. of D C) = 4,500 × 17 = 76,500 lbs.

Therefore, taking moments above B of P and the coal thrust on A B, P × 6.47 = 9496 cos 15° × $\frac{8}{3}$

∴ P = 3781 lbs.

Next to find the stress Q in the horizontal tie, the part of the bin with the mass of coal A B C D enclosed in part by the bin along A B and B C, is in equilibrium under the action of P, Q, W (on 17 ft.), the thrust on C D (for

17 ft.) and the reaction at C; hence taking moments about C,

$$Q \times 11.5 = 76{,}500 \times 6.5 + 149{,}141 \times 4.73 - 3{,}781 \times 9.3$$
$$\therefore Q = 101{,}524 \text{ lbs.}$$

It is suggested though, that all the coal that may be supposed to rest on the two ties should likewise be considered in their design.

In case the coal is heaped above the line A D, the thrust can be estimated by the graphical method alluded to above. The aim has been in what precedes to emphasize the need of properly including the wall friction, especially in retaining walls proper. That this friction exercises a marked influence is shown in the article on "The Pressure of Stored Grain," on p. 64 of the current volume of Engineering News, also in the issues for May 15 and 29, 1886, giving, by weighing, the exact weight of sand held up by the sides of a box when the bottom was gradually lowered. The issue for March 3, 1883, on "A Study of the Movement of Sand" will likewise repay reading, also the experiments in "Annales des Ponts et Chaussees" for April, 1887, relative to wall friction.

Yours respectfully,

Wm. Cain.

University of North Carolina, Chapel Hill, N. C., Feb. 7, 1898.

Notes and Queries.

Information regarding smokejacks and ventilators for locomotive roundhouses is desired by a committee of the Association of Railway Superintendents. Replies should be addressed to Mr. Geo. W. Andrews, care B. & O. R. R., Wilmington, Del.

"F. I. W." inquires as to the most satisfactory compound for "preparing cloth for blue prints"; and also the necessary ingredients and proportions for making "brown prints." Will some of our readers who are posted in the latest methods answer?

E. L. S. writes: "Will you please inform me through the columns of your paper if there is any simple method of recoating tracing cloth which has become damaged by opaque spots due to drops of water. What is the composition ordinarily used in coating the cloth and making it transparent?"

We refer the inquiry to our readers.

E. H. B. asks for the names and addresses of the different projectile making companies in England and Scotland.

The principal ones in this country are the Carpenter Steel Co., Reading, Pa.; Isaac G. Johnson & Co., Spuyten Duyvil, New York city; The E. W. Bliss Co., Brooklyn, N. Y.; The Midvale Steel Co., Nicetown, Philadelphia, Pa. In Europe the principal makers of ordnance also manufacture projectiles.

L. B. H. writes: "Kindly send us a formula by which to calculate the effective blow of a steam hammer (Vulcan)."

The total energy of the blow of a steam hammer may be calculated as follows:

Let
W = weight in pounds of the falling mass,
H = height of the fall in feet,
A = area of the steam cylinder in sq. ins.,
P = mean effective pressure of the steam in the cylinder in lbs. per sq. in.

Then total energy in foot pounds = W H + A P H.

The effect of a blow cannot be measured directly in pounds, but only in foot-pounds or like compound unit. We quote the following discussion of the subject from Kent's "Mechanical Engineers' Pocket Book," p. 430:

The question is often asked: "With what force does a falling hammer strike?" The question cannot be answered directly, and it is based upon a misconception or ignorance of fundamental mechanical laws. The energy, or capacity, of doing work, of a body raised to a given height and let fall cannot be expressed in pounds, simply, but only in foot-pounds, which the product of the weight into the height through which it falls, or the product of its weight ÷ 64.32 into the square of the velocity, in feet per second, which it acquires after falling through the given height. Just as the energy of the body is the product of a force into a distance, so the work it does when it strikes is not the manifestation of a force, which can be expressed simply in pounds, but it is the overcoming of a resistance through a certain distance, which is expressed as the product of the average resistance into the distance through which it is exerted. If a hammer weighing 100 lbs. fall 10 ft., its energy is 1,000 ft.-lbs. Before being brought to rest it must do 1,000 ft.-lbs. of work against one or more resistances. These are of various kinds, such as that due to motion imparted to the body struck, penetration against friction, or against resistance to shearing or other deformation, and crushing and heating of both the falling body and the body struck. The distance through which these resisting forces act is generally indeterminate, and therefore the average of the resisting forces, which themselves generally vary with the distance, is also indeterminate.

THE HYDRAULIC LIFEBOAT "QUEEN."*

By John Platt, Assoc. Mem. Am. Soc. of Naval Engineers.

The hydraulic life boat "Queen" was designed by Mr. G. L. Watson, the naval architect to the Royal National Lifeboat Institution, who furnished drawings and a specification, the builders being responsible for the design of the machinery, and for the attainment of a speed of 8½ knots.

The particulars of the vessel are:

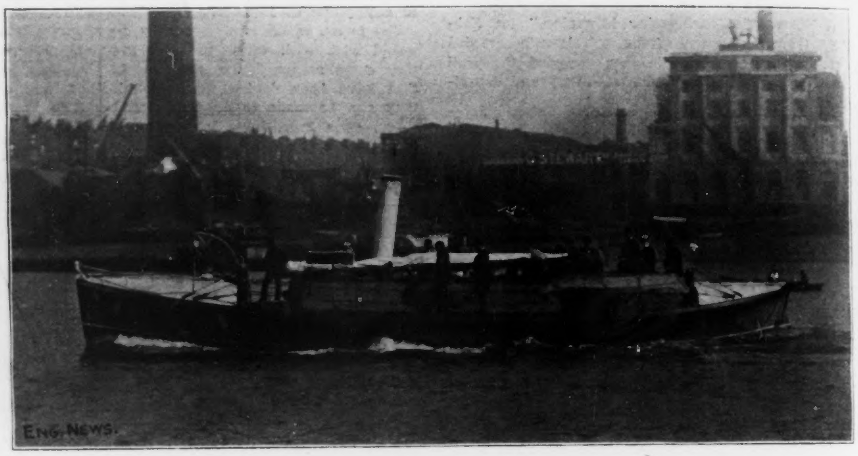
Length over all	55 ft.
Length on water line	53 ft.
Breadth molded	13 ft. 6 ins.
" extreme over belting	16 ft.
Depth molded	5 ft. 6 ins.
Draft, extreme	3 ft. 6 ins.
Displacement	30.08 tons.

The hull is of galvanized mild steel, having a tensile strength of 52,240 to 67,200 lbs. per sq. in. and an elongation of 20% in 8 ins. The plating weighs between 7½ lbs. and 4½ lbs. per sq. ft. The seams are double riveted, and the butt laps are treble riveted in way of engine and boiler rooms and double riveted elsewhere. The hull is closely subdivided, and the bulkheads are intact, the only water-tight doors being in the coal-bunker bulkheads. Access is obtained to the small compartments for the purpose of examination and painting by manholes jointed with red lead in the bulkheads above the water line. Longitudinal wing bulkheads extend for a length of 25 ft. 6 ins. on each side, enclosing the machinery space. They are 2 ft. 6 ins. from the side at the height of the water line amidships. They considerably reduce the volume of the machinery compartments, which are unavoidably long, and afford security in case of injury to the boat's sides. The wing compartments are subdivided by athwartship bulkheads and on each side of the boiler room one of the compartments thus joined is used as a coal bunker. Two strong side protective keels of American rock elm are fitted between angle bars, the bolts going through the flanges of the bars, and not through the bottom plating. These are placed under the longitudinal side bulkheads, and are an effective protection to the pump inlet and to the bottom.

In the stern is the open cock-pit capable of holding about 45 people. The deck of the cock-pit is above the water and is water tight. It is provided with the usual freeing valves to allow of the rapid exit of the water in case of a sea being shipped. The rudder projects below the bottom of the boat in the usual lifeboat fashion; the rudder head is hexagonal in section for a length of about 2 ft. and can slide up and down in a quadrant into which is geared a worm spindle which carries the steering wheel at its inboard end—the rudder can rise if it strikes the bottom, or can be triced up with tackle provided for the purpose without disconnecting the steering gear. In the matter of steering, the hydraulic lifeboat has a decided advantage. The engines and the centrifugal pump, which forms the propeller, naturally always turn one way, and reversing is effected by directing the flow of water either ahead or astern. The vessel is always easily managed by means of the jets. At the forward end of the cock-pit, upon the engine casing, is a steam capstan, and a steel wire rope hawser is coiled on a reel close to it. A wire rope nipper is placed upon the forecastle and an arrangement is provided for cutting the hawser in case of need. There are two sails, a dipping lug and a forestaysail. The mast can be hinged down upon the top of the boiler casing.

A double-compound surface-condensing inclined engine is used having cylinders 8½ and 14¼ ins. in diameter by 12 ins. stroke. The cylinders are inclined and actuate a single crank on a nearly vertical shaft. The air and bilge pumps and the two feed pumps are driven from the main engine. An independent engine and circulating pump supplies water to the condenser. The usual auxiliary feed pump is placed in the boiler room. The main turbine and casing are of bronze, zinc protectors being provided to prevent galvanic action between the pump and the shell of the boat, should the zinc coating of the latter be worn off. The inlet pipe is of steel and the discharge pipes are of copper. The diameter of the turbine is 2 ft. 6 ins., and at a speed of 9 knots the discharge is about 2,240 lbs. of water per second. The nozzles are 9 ins. in diameter. These nozzles are carried well forward and aft. The distributing or reversing valves are placed at the junction of the ahead and astern discharge pipe. The nozzles for propelling astern are above water and are protected by the belting. The design of the inlet is such that the water is conveyed to the pump without shock, and the cross section immersed areas of the hull in way of the inlet are so formed as to allow the water to enter the pump without disturbing the natural flow of the stream lines.

A series of trials was run with the "President Van Heel," a previous hydraulic life boat described by Mr. S. W. Barnaby in Proc. Inst. C. E., Vol. 130, Part IV., to measure the I-HP. required to drive the vessel at different speeds. The boat was brought to a draft of water corresponding with a displacement of 30.08 tons. The guaranteed speed of 8.5 knots was obtained with 123 I-HP., the engines working at half power. With 246 I-HP. the speed was 9.29 knots. Much power is wasted by a hydraulic propeller when driven far above its designed speed. This, together with the fact that the length and form of the boat were not adapted for speeds above 8.5 knots, accounts for the extremely rapid rise of the power curve, which appears to be almost asymptotical to a speed of 10 knots, that is to say, it would not seem possible to obtain that speed however fast the turbine might be driven. The object of providing such a large reserve of power in the boat was not that she might be driven at a greater speed than 8.5 knots, but to ensure that the power wanted for this speed might be attained without difficulty under the arduous conditions of the service.



THE HYDRAULIC LIFEBOAT "QUEEN."
Built for the Royal National Lifeboat Institution by John I. Thornycroft, London.

A Thornycroft water tube boiler of the "Speedy" type is fitted in the boat. The effective heating surface is 610 sq. ft. and the grate area is 11.4 sq. ft. The steam pressure is 150 lbs. per sq. in. and the test pressure 300 lbs. The drums are of Siemens-Martin steel 5-16-in. thick increased to 9-16-in. thick at the tube plates. The tubes are of solid drawn steel 1-in. external diameter. No. 14 B. W. G. thick. It was found that the boiler did not prime although the movements of a vessel of this class are very violent when running in a sea way. Steam can be raised from cold water in 20 minutes.

The remainder of the paper described a series of tests made upon the boiler before placing it in the boat to determine the most efficient method of burning either coal or oil fuel in its furnace. It was found quite difficult to so adjust the oil burners and the air supply as to secure good combustion and prevent smoke. A brick arch in the furnace gave excellent results but considerably increased the time necessary to raise steam. Tests were also made with the grates covered with broken brick, which gave good results. In the tests with oil fuel a considerable amount of coal was also burned in the grates. The evaporation from and at 212° F. per lb. of coal when coal alone was used for fuel was from 8.25 to 10.17 lbs. The water evaporated per hour per square foot of effective boiler heating surface was from 5½ to 7½ lbs. The temperature in the uptake was from 700° to 800°.

*Condensed from a paper read at the Washington meeting of the American Society of Naval Engineers, Jan. 8, 1897.

PNEUMATIC PERCUSSION RIVETERS.

The days are still within the memory of many men still in active life when all riveted work was done by hand, and hard, noisy and expensive work it was. The power riveter working with hydraulic, steam or air pressure long ago displaced handwork for all places where such tools can be used; but there are frequently contracted places, in riveted work, where the power riveter cannot reach, and here hand riveting is still in use.

Recently, however, the pneumatic hammer principle, which has been so widely and successfully applied in the operation of a variety of tools for stone and metal working, has been made use of in the design of a power riveter, which is applicable to a large part of the work which has hitherto been done by hand. This machine is now in extended use for bridge, boiler and structural work, and it is illustrated in the accompanying engravings. As seen by Fig. 1 this machine consists of a pneumatic riveting hammer and pneumatic hold-on attachment on opposite ends of a horseshoe

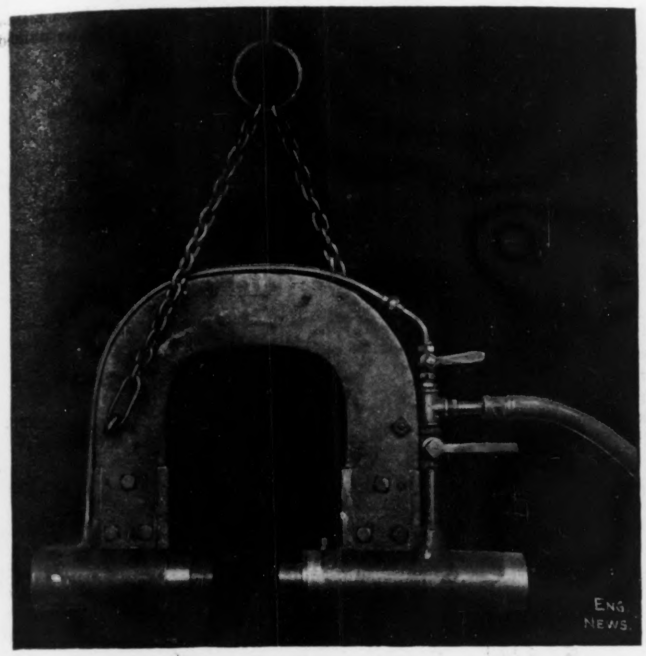


FIG. 1.—PNEUMATIC RIVETER WITH YOKE.

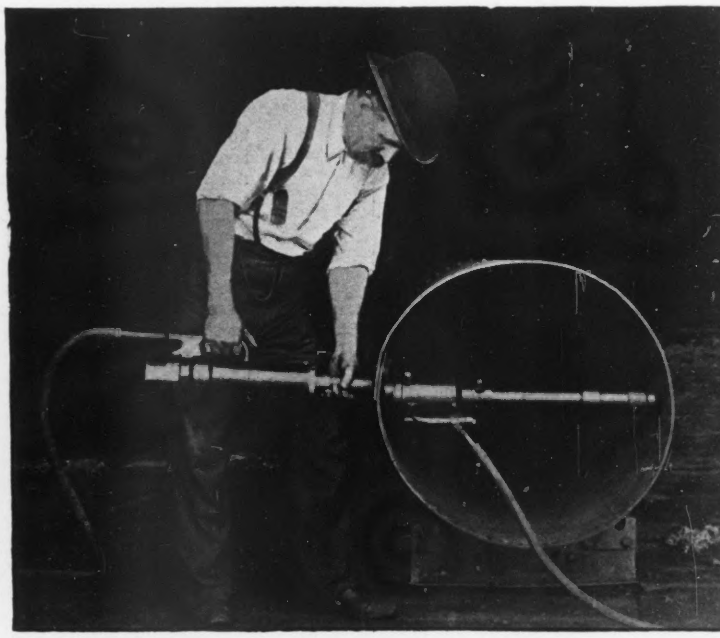


FIG. 2.—DUPLEX PNEUMATIC RIVETER AND PNEUMATIC HOLD-ON FOR BOILER WORK.

yoke which can be suspended by chains from a derrick or crane. If both chains are attached to the same side of the yoke, this will be suspended in a horizontal plane, while if both are attached to the same leg of the yoke the hammer will be in a vertical position. Two regular sizes are made. The first has a 6-in. opening between the dies, and a steel yoke ¾ × 4 ins. in section, with a throat 12 ins. deep; this weighs 85 lbs. and will drive ⅞-in. rivets, with a consumption of about 35 cu. ft. of free air per minute. The other has a 7-in. opening, and a yoke 1 × 5 ins. with a throat 16 ins. deep; this weighs 175 lbs. and will drive 1⅛-in. rivets, with a consumption of about 50 cu. ft. of free air per minute. The machines are so light that they can easily be handled, and so small that they can be used in cramped and awkward work, while the yokes can be made of any desired width and depth. Where a considerable depth of throat or gap is required, the yoke is made of 4-in. or 6-in. pipe, with an iron ball attachment for the chain.

The riveter may be rigged up in various ways to suit the character of the work. For bridge and structural work it is generally suspended by its chains from a counterweighted lever, hung from an overhead support, which greatly facilitates getting it into position. For smokestacks, tanks or water towers it can be supported on the work or hung from the mast or derrick which raises the plates into place. At the shipyards of the Globe Iron Works, Cleveland, O., a riveter with flat steel yoke is attached to the legs of an angle iron A-frame which acts as a counterbalance, a transverse roller on the frame resting on the top chord of the plate-girder keelson of a ship. The machine can thus be run to and fro, and as the frame turns loosely on the roller journals the riveter can be raised and lowered as desired, to rivet up the vertical stiffening angles and other connections. At the shipyards of the Chicago Shipbuilding Co., a riveter with pipe yoke is suspended by its bail from a differential pulley hung on a frame built up of gas pipe, while another similar riveter is suspended from a differential pulley running on the top bar of a frame fitted with wheels which run along the girders and frames of the ship. A. Lucas & Sons, of Peoria, Ill., state that they find the yoke riveter very handy for work on roof trusses and structural work requiring frequent moving of the riveter.

For boiler and tank work, the use of a separate duplex riveter and pneumatic hold-on is considered preferable, and this arrangement is shown in Fig. 2.

It will be noticed that the rivet on which the tool is at work in this engraving is one on which a pressure riveter might easily be used; but the photograph was taken merely to illustrate the operation of the tool, and the position was chosen to get a good light upon it, which is, of course, impossible in the locations where it is ordinarily used.

This riveter, capable of driving ⅞-in. rivets, weighs only 35 lbs., and is not severe upon the one operator required to handle it. The special feature of this is the counterbalancing arrangement by which the shocks and vibrations are reduced, and this is effected by means of a cylinder and piston, moving in such relation to one another that they strike alternately. This same principle has been applied to a counterbalanced hammer for calking, chipping and light riveting, which is claimed to be far less severe on the operator than any form of pneumatic hand hammer. Two pistons are used (the striking piston and the counterbalanced piston) working in opposite directions, by which

Fig. 3.—Counterbalanced Pneumatic Hammer for Calking, Chipping and Light Riveting.

means the shock and vibration are almost entirely absorbed. This tool, Fig. 3, is 13 ins. long, weighs 13 lbs., and consumes about 25 cu. ft. of free air per minute. It is used in boiler shops for chipping and calking, and in shipyards for driving rivets up to ½-in. diameter.

Mr. C. W. Hawkes, Superintendent of the Springfield Boiler & Mfg. Co., writes us that while a pressure riveter is the best machine for boiler work, yet there are always more or less rivets which have to be driven either by hand or snap; and he finds that the pneumatic riveting hammer and hold-on, as shown in Fig. 2, gives better results than either of these methods.

These tools are in use at a number of important plants, and are manufactured by the Ridgely & Johnson Tool Co., of Springfield, Ill., who state that the yoke or duplex riveters should readily drive from 800 to 1,200 rivets per day, at a cost one-third to one-half that of doing the work by hand. This firm has also built, for the Pullman Palace Car Co., a special stationary machine for riveting drawbar heads. This weighs 1,200 lbs., and is fitted with a plate-closing device.

NOTES FROM AMERICAN BRIDGE SHOPS.

I.

Elmira Bridge Co., Elmira, N. Y.—The original works of this company, now known as the "South Shops," are located on the line of the Erie R. R., in the southern outskirts of the city of Elmira, N. Y., and comprise a rivet shop, forge shop, machine shop, template shop, power-house, offices and various smaller buildings for special processes. A couple of years ago, however, the company, finding that it was outgrowing its original accommodations, and being unable to secure additional land near its old site at reasonable terms, obtained a tract of about 25 acres a few miles north of its old works and began the erection of a second plant. Up to this time only a rivet shop, 100 × 400 ft., with a complete yard equipment and subsidiary buildings for the power plant, plate rolls, edge planers, and angle straightening presses, have been erected at the new site; but all future additions to the company's plant will be made here. The new plant is known as the "North Shops," and at the time of the writer's visit, these and the South Shops were both running at about one-half capacity.

At the South Shops the company has to depend for shipping facilities entirely upon the Erie R. R., but the tracks of both the Erie and the Lehigh Valley railways enter the yards of the North Shops. The movement of material in the yards is accomplished by means of tram car tracks and stiff-leg derricks. At the South Shops the straightening is done by hand, but at the newer plant there are both angle straightening presses and plate rolls. At these works the writer observed a rather novel form of "table" in front of the large plate edge planers. Instead of the common platform, or carriage, mounted on wheels, there was a cluster of cast-iron pedestals spaced something like 2 ft. apart in both directions. These pedestals occupied an area large enough to provide for the largest size plates and carried at their tops an ordinary swiveling castor wheel (Fig. 1). The plate rested on these castors, which allowed easy movement in any direction and at the same time allowed the men to get around and close to the plate by passing between the pedestals.

In the rivet shops at both works, beginning at the yard end, came the lay-out room, shears, punches, drills and reamers, and last, the riveters at the end where the finished work is discharged. Among the special machines noted in these buildings, a machine for milling the ends of angle stiffeners and an automatic multiple punch deserve mention. The operation of the milling machine is, perhaps, best made clear by a sketch (Fig. 2).

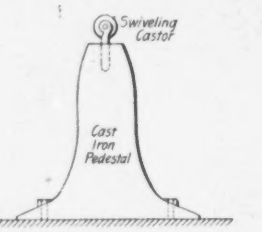


Fig. 1.—Pedestal with Swiveling Castor for Plate Edge Planer "Table," Elmira Bridge Co.

(A cluster of these pedestals forms the table on which large plates are supported and shifted in the process of edge planing.)

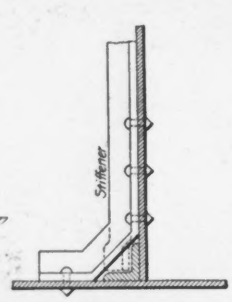


Fig. 4.—Angle Stiffener Construction for Plate Girders for South African Railways, Union Bridge Co.

In ordinary plate girder work, as is well known, the angle stiffeners are crimped over the web flange of the chord angle. One flange of the angle stiffener bears in the fillet of the chord angle and has to be machined to fit the curve, while the other flange is cut square. Ordinarily the end of the stiffener is first planed or milled square and then the fillet flange is ground to the proper curve on an emery wheel. In the machine described, however, a special cutter mills both the square and curved flanges of two stiffeners at one cut. A glance at the sketch will make the machine work clear and also explain its purpose.

The multiple punch is a still more notable labor-saving device. Briefly described, it consists of a gang of nine punches set in line in a single frame, the depth of the throat of which is 42 ins. The plate to be punched is carried under these punches by means of a traveling carriage operated by a rack. This rack is so arranged that the movement of the plate is a series of shoves with short intervals of rest, during which the holes are punched. By properly arranging the rack motion it will be seen, therefore, that the holes may be punched at any desired distance apart in the direction of the longitudinal motion of the plate, while the ability to operate all or any smaller number of punches individually, or in groups, gives a large variety of spacing across the plate. It is in simple, straight work, however, that this punch seems to offer the best opportunities for economy, such, for example, as plate girder web plates, where a single pass of the plate will punch the holes for the flange angles, shelf angles and stiffeners. Another use to which it is very well adapted is the punching of the plates for use in making up compression members. For example, in a bridge end post the holes for the angle connections and also for connecting the pin plates may be punched at one pass of the plate. In fact, the variety of plate work to which the punch may be adapted with economy is very large, and with some modification it may often be employed on angles, T-bars, and other straight work other than plates.

The extensive use of compressed air power in the rivet shops of both plants was a particularly noticeable feature, this agent being used to run all portable drills, reamers, chippers and riveters. In the new shop the compressed air pipes are laid underneath the floor, through which cocks project at frequent intervals for the hose connections. Outside the buildings air is also used for all these processes of riveted work. A central compressor at each works supplies the air, and the writer was told that decided economy in its use had been obtained by reheating. This reheating was accomplished by the very simple process of passing the air through a coil inclosed in a hood over the rivet heating forge, or placed inside a common stove. In out of door work in cold weather reheating was found to be necessary to keep the machines from freezing.

In the template shop the rather unusual practice is adopted of laying out full size trusses on the benches, as is shown by the accompanying view (Fig. 3), which shows a parabolic roof truss for a drill room fully laid out on the benches. The advantage of using benches for such layouts, instead of the floor, is said to be chiefly due to the greater convenience with which the men work. It will be noticed from the illustration that the aisles between the benches can be bridged over wherever it is necessary, so that for all practical purposes their tops form a continuous surface for the layout.

Union Bridge Co., Athens, Pa.—A short two-hours' ride from Elmira takes one to the still larger works of the Union Bridge Co., located on the line of the Lehigh Valley Ry., at the little town of Athens, Pa. As is quite well known, this company possesses one of the five testing machines in the United States which are capable of breaking full-size eye-bars of the larger sizes, and its hammer shop and annealing furnaces for eye-bar manufacture are among the largest in the country. At the time of the writer's visit, however, no eye-bar or other heavy forge work was under way, and the only indication of the big testing machine's vast power was a pile of broken bars that lay near by. For the benefit of those who may have forgotten the published figures, however, it may be stated here that the total capacity of the machine, either in tension or compression, is 1,244,000 lbs., or 622 tons, and that it will break a bar 40 ft. long with a stretch of 12 ins.

Besides the eye-bar forging and testing plant, the works of the company comprise a general forge shop, a machine shop, a rivet or truss shop, a template shop, and the usual drafting rooms and offices. The angle straightening presses, plate rolls, coping machine, and plate edge planers are in small individual buildings, scattered about the unloading yard at points most accessible to the incoming material of various kinds.

In the rivet and machine shops all hands were busy on the big pin-connected spans for the new Victoria Bridge, across the St. Lawrence River, at Montreal, and the heavy posts and chord members lay about in all stages of completion. Among the machines noticed in the rivet shop was a duplicate of the multiple punch previously mentioned as having been seen at Elmira. The operation of this punch has already been described, and the description will not be repeated, but some notes of its work are worthy of mention. Generally five men are employed in its operation. The duty of two of these hands is handling the plates on and off the carriage, while the other three operate the machine proper. With this force and upon ordinary plate girder work the capacity of the punch is easily 1,200 holes per hour. This record, the writer was told, was often reached in the work upon the web plates for the 23-ft. and 40-ft. plate girder spans of the Northwestern Elevated Ry. of Chicago. Ordinarily four web plates per hour were put through the machine, including all loading and preliminary work. In this same work the machine was fitted with a special device for holding four angles, and in two passes of the carriage the web plate and four chord angles for a plate girder were punched ready to be assembled. As cover plates were not required in these girders, only the angle stiffeners remained to be punched to turn out all the parts of a complete plate girder ready for riveting.

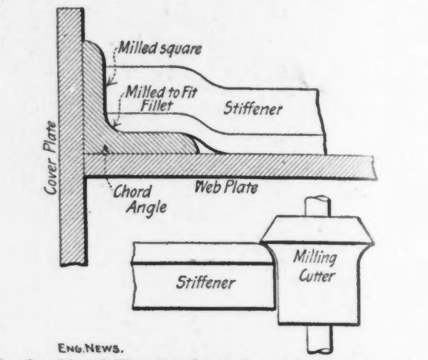


Fig. 2.—Sketch Showing Operation of Machine for Milling the Ends of Angle Stiffeners. Elmira Bridge Co.

The work in the machine shop was confined mostly to finishing the pins and segmental rollers for the new Victoria Bridge. As may be remembered from the description of this structure published in Engineering News of Aug. 26, 1897, the material of these segmental rollers is cast steel. The finishing process as carried on here consists first of a longitudinal planer cut along the segmental surface to remove the rough surface, next a transverse cut following the line of the arc of the segment, and, finally, the grinding. In other words, practically the same process was adopted as is used in finishing pins.

In the template shop the carpenters were found busy getting out the patterns for a large order of plate and lattice girder work destined for South Africa. The contract includes altogether 27 girders, the longest of which are 100 ft., and all of which are of English design. Insignificant as this work is in size, it afforded a good illustration of how slight peculiarities in design add to the difficulty and cost of shop work. The angle stiffeners were designed, as shown in the accompanying sketch (Fig. 4). Now, as is well known, the Ameri-

FIG. 3.—INTERIOR VIEW OF TEMPLATE SHOP AT ELMIRA BRIDGE WORKS, SHOWING METHOD OF LAYING OUT TRUSSES ON BENCHES; ELMIRA BRIDGE CO.

can practice would be, where a filler plate is not used, simply to crimp the angle, as shown by the dotted lines, and every American bridge works has a drop hammer or press for performing this operation quickly and cheaply. With the design shown, however, the stiffener has to be forged under the hammer or else a special bending machine or bull-dozer must be provided for the work. This is, perhaps, a very small matter, but at the same time it is such simple things that are often the most useful to young designers.

Another foreign order, which at the time of the writer's visit had not got beyond the drafting room, was a steel pier to be erected at the port of Progreso, on the northern coast of Yucatan. This pier is to carry a double line of railway track and consists of lattice girder spans 30 ft. long, supported by solid cast steel piles 6 ins. in diameter driven into the rock bottom of the harbor. The piles are placed in rows of four piles each, extending transversely across the pier, which is 43 ft. wide, and are fitted with cast-iron caps to support the girders. The idea is to drive the piles with an ordinary pile driver until their tops are slightly below grade, and then to set the cast-iron caps and level them up to grade by the use of rust cement. This method, it will be seen, allows slight variations in the heights of the piles to be remedied without cutting off the tops—an almost impossible task with a solid column of cast steel 6 ins. through, away from adequate machinery—or without the necessity of making special caps.

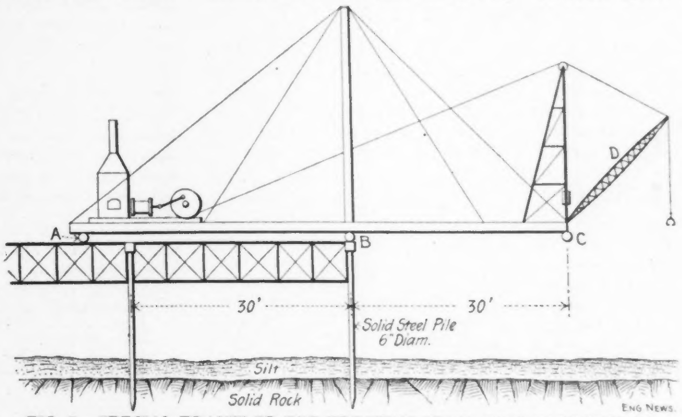


FIG. 5.—SPECIAL TRAVELER FOR ERECTING STEEL PIER IN PROGRESO HARBOR, YUCATAN; UNION BRIDGE CO.

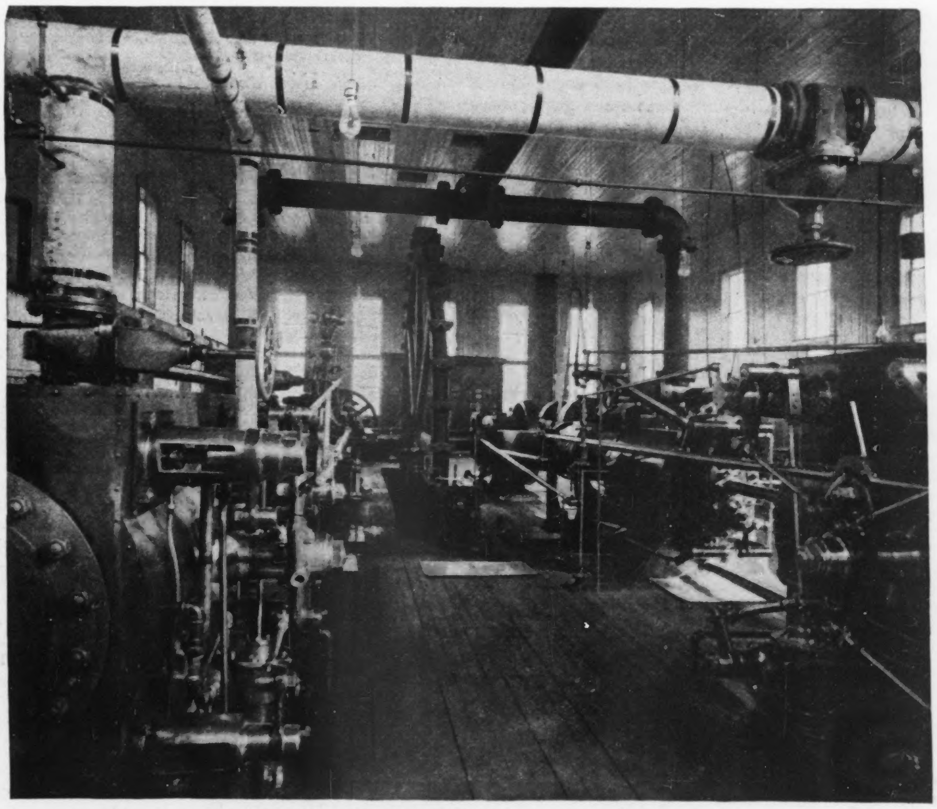
For the erection of this pier, a special traveler has been designed which is worthy of separate mention. Its construction is very roughly indicated in the accompanying sketch (Fig. 5), drawn from memory. In operation this traveler will be run forward until the wheels B stand directly over the last row of piles driven. In this position the pile driver is in the proper position to drive the succeeding piles. When this is done the traveler is moved back until the wheels C occupy the position formerly occupied by the wheels B. The boom D is then stepped to the pile driver as a mast, and the girders, cross frames and lateral system of the truss spans are swung into position and bolted. The former operation is then repeated until the pier is finished.

Inquiry as to the reason for the expensive use of the costly solid cast steel piles instead of tube or cylinder piles, brought out the information that they were considered preferable both for their greater durability when subject to erosion, and because they had to be very stiff to withstand being driven into the rock bottom. It was also stated that this was the second pier of this construction to be erected, but the location of the preceding one had been forgotten.

THE LARGEST PELTON WATER-WHEEL IN THE WORLD.

The illustration given herewith shows an air compressing plant recently installed at the Alaska-Treadwell mine, Douglass Island, Alaska. In this installation a duplex-Riedler compressor with 24-in. cylinders is driven by a horizontal, cross-compound condensing engine, with 24-in. and 36-in. cylinders and a 36-in. stroke. The steam cylinders are placed back of the air cylinders and the piston rods are provided with couplings. Instead of the usual flywheel, a Pelton water-wheel, built by the Pelton Water Wheel Co., of San Francisco, is mounted on the compressor shaft. This is the largest Pelton wheel in the world. It is 22 ft. in diameter, weighs 25,000 lbs., and will, when running under a head of 480 ft., at its normal speed of 75 revolutions per minute, develop 500 HP., delivering 2,800 cu. ft. of free air per minute. The largest wheel previous to this is operated by the North Star Mining Co., Grass Valley, Cal., and is 18 ft. 6 ins. in diameter (Eng. News, Dec. 19, 1895).

At times when, from any cause, it is necessary to shut off the water, the piston rods are connected and the engine started up. Suitable speed regulators for both water-wheel and engine are provided. According to reports from the superintendent of the company, compressed air saves fully 20% in power over the ordinary methods of transmission by rope or belt. The engine and compressor were furnished by Fraser & Chalmers of Chicago.



A COMBINED STEAM AND WATER POWER COMPRESSOR.
Fraser & Chalmers, Chicago, Ill., and the Pelton Water Wheel Co., San Francisco, Cal., Builders.

THE TRANS-SIBERIAN RAILWAY, says Imperial Railway Commissioner Chilkoff in a late report to the Czar, will be opened to traffic throughout its entire length by the summer of 1899. The journey from St. Petersburg to Vladivostock may then be made in ten days. The Russian Commissioner figures that the globe may then be circled in 33 days as follows: St. Petersburg to Vladivostock, 10 days; Vladivostock to San Francisco, 10 days; San Francisco to New York, 4½ days; New York to Bremen, 7 days; Bremen to St. Petersburg, 1½ days. By special trains and fastest steamers this time could be reduced to 28 days, he says, with an allowance of 7 hours for delays.

TO ENCOURAGE SETTLEMENT ALONG ITS LINE, the Madras Railway Co., of India, offers a free third-class periodical pass, renewable for a total period of five years in favor of one owner or tenant of a new house at or near any of the stations on a certain section of the line. But the following provisions are annexed: The house must have been built since March 1, 1896; it must be within a radius of one mile of the station; the site of the house must be approved by the chief engineer of the railway company, and he must value the house at not less than 1,000 rupees, or say $500 in silver.

THE PENNSYLVANIA RAILROAD CO., according to its late annual report, earned in the last year $64,223,000 on the three grand divisions east of Pittsburg and Erie. The operating expenses were $43,257,000, and the net earnings $20,965,000; with other income added these net earnings were $26,549,000. The fixed charges and rentals were $15,626,000, leaving $10,833,131, or nearly 8% for the common stock. But $1,067,000 has been set aside for an extraordinary expenditure fund, a new departure and intended to provide money in any emergency for "the completion of work already authorized." The profit and loss account was also reduced $2,409,000 by reducing the valuation of coal companies, equipment, etc. The gross earnings of the whole Pennsylvania system, east and west of Pittsburg, were $128,278,000, an increase of $4,600,000 over last year. The operating expenses were $87,600,000, or over $7,000,000 per month, and the net earnings of $40,637,000 showed an increase of $5,325,116 over 1896. The total freight moved was 159,000,000 tons.

THE DELIVERY OF TRAIN ORDERS to trains while running at speed has been practiced for some months on Meadville Division of the Erie R. R. between Salamanca, N. Y., and Kent, O., and on the Western Division of the Philadelphia & Erie R. R. The device used is the invention of Mr. C. J. Quay, of the Erie R. R. The folded order is securely held in a spring attached to a very light wooden hoop, 12 to 18 ins. in diameter. Telegraph operators are provided with a light stick with a spring clip at the end in which the hoop is held. When they wish to deliver an order to a train, they stand on the platform and hold out the hoop with the order secured in it. The engineer catches the hoop on his arm as he passes by and carries it along with him, while the stick remains in the operator's hands. The hoop weighs less than an ounce, and there is no trouble in catching it when the train is running at 40 miles an hour. Mr. Quay, writing from Meadville, Pa., informs us that in the month of January train orders on one division were delivered to 426 trains by this device. It should be explained that on the Erie and the Philadelphia & Erie divisions, where this device is in use, conductors and engineers are not required to receipt for all train orders. On the Erie lines from Chicago to Salamanca, N. Y., since June 1, 1896, the "19" order, requiring no receipt by the trainmen, has been used for all trains of inferior rights. Holding orders to trains having right of way must of course be receipted for by the conductor and engineer.

As already described in this journal, the Erie also has in use at some of its most important stations the Mozier automatic "19" order semaphore for indicating and delivering orders to passing trains. Its more general adoption is being urged by several of the superintendents on whose divisions it has been on trial. By its use the operators are allowed to remain at their posts while trains are passing, and as it has the regulation size semaphore blade, with full-size signal light at night, it can be seen at a long distance and give regular indications; horizontal, diagonal and vertical, the signal light showing red, green and white. On the Philadelphia & Erie, we are informed by Mr. J. W. Reynolds, Superintendent of the Western Division, that the orders for which trainmen are not required to sign are those which would result only in detention to the train, such as orders giving a train of inferior class time to make a station against a train of superior class. The corresponding order to a train of superior class would be receipted for by the engineman and conductor.

A SHIP CANAL AT DULUTH, through Minnesota Point, is contemplated by a newly organized company, to afford an easier entrance to the harbor, and especially to the iron ore docks of the Duluth, Missabe & Northern Ry. A toll will be charged for going through the canal; but this would amount to less than the tug charges for the present entrance.

THE NICARAGUA CANAL COMMISSION, says a San Carlos item of Jan. 30, is meeting with some delay in its surveys of Lake Nicaragua, owing to a prospective revolution that keeps the steamer needed securely anchored under the guns of the fort at the lake end of the San Juan River. But the hydrographic party under Lieut. Hanus is reported as having found a shorter channel to deep water in the lake, reducing to 11 miles the distance from the San Juan River to 6 fathoms of water. The lake shore line about the mouth of the river is also being more accurately mapped.

THE CHICAGO-NICARAGUA CANAL PARTY, under the engineering direction of Mr. Lyman E Cooley, has returned. This party of eighteen men, engineers, geologists and contractors, left New York on Dec. 30 for Colon; they spent three days on the Panama Canal and then went to Corinto and Managua, where they joined the U. S. Nicaragua Commission, and accompanied that body to Rivas, on the Western division of the proposed canal. After spending four days west of the lake, they went across the lake and down the San Juan to Castillo, and then tramped for five days over the line and the divide cut. They then went to San Jose, in Costa Rica, and returned home.

THE MASSACHUSETTS MARITIME CANAL CO. is applying to the Committee on Harbors and Public Lands of the Massachusetts legislature to have its old charter extended, promising to put up the required $200,000 in ten days. This company is proposing to build the Cape Cod Canal, and two years ago failed to meet its deposit with the State. The matter has been laid over until March 11, to allow engineers to testify as to the feasibility of the scheme.

THE HAMBURG-AMERICAN STEAMSHIP "Pretoria," the sister ship of the "Pennsylvania," has arrived in New York, 11 days out from Hamburg. The "Pretoria" was built by Blohm & Voss, of Hamburg, while the "Pennsylvania" was built at Belfast, Ireland. The "Pretoria" is 586 ft. long, over all, 62 ft. beam, 42 ft. deep from keel to awning deck, has a displacement of 20,000 tons and is 12,800 tons gross and 8,139 tons net register. She has a double bottom and 12 water-tight bulkheads. The twin screws are driven by quadruple expansion engines developing 6,000 HP. She has accommodations for 260 first-class and 150 second-class and 1,000 steerage passengers, and can carry 18,000 tons gross of freight. Twenty-two lifeboats are carried. On her westward trip she averaged 14 knots speed.

THE HOLLAND SUBMARINE TORPEDO BOAT, lately completed at Nixon's Shipyard, at Elizabeth, N. J., is being practically tested. The boat has shown her ability to navigate on the surface, to dive and to move at a considerable speed when submerged 20 ft. below the surface. The inventor, Mr. J. P. Holland, says the boat behaved "even better than he expected."

THE TRACTIVE POWER OF ELEPHANTS, HORSES and men was lately tested at Barnum & Bailey's Circus, in London, says "Engineering." An instrument capable of recording a tractive force up to 30 tons was anchored to the floor. Two powerful horses were first attached to it, capable of drawing a load of 8 to 9 tons on an ordinary road. Their pulling record on the dynamometer was 1.2 tons. The largest elephant was next yoked to the instrument and gave a record of 1.85 tons and then 2½ tons. But a smaller elephant with more spirit gave a pull of 5½ tons. In the further trial it was shown that 83 men were about equal to one elephant, their combined pull registering 5.6 tons. In the case of both the horses and the men, however, the collective maximum force was probably not reached, as training is required to this end. The elephant, by throwing its weight suddenly against the instrument, might also produce a tension, says "Engineering," far in excess of any steady pressure it could exert.

BOOK REVIEWS.

PRELIMINARY SURVEY AND ESTIMATES.—By Theodore Graham Gribble, C. E. Second edition. London and New York: Longman, Green & Co. Cloth, 7 x 4¾ ins.; pp. 458; illustrated.

The second edition of this handbook has had considerable new matter added to it. We have already reviewed this work, and found it useful for the purpose intended. It is to a large part based upon American practice. Mr. Wellington's "Economic Theory of Railway Location" is freely quoted, and the practice of many prominent American engineers is cited. The contents cover general considerations; reconnoissance; hydrography and hydraulics; geodetic astronomy; tacheometry; chain-surveying; curve running; graphics for preliminary estimates; instruments, etc. An interesting chapter explains the Parliamentary work required in England for the submission of plans to that body and the conditions under which permission to build can be granted.

THERMODYNAMIQUE DES SYSTEMES HOMOGENES.—Par E. Aries, Chef de bataillon du Genie. Gauthier-Villars et fils, Paris. Paper; 12mo.; pp. 173; 3 francs.

This small volume is one of a long series of scientific books issued in similar form under the general title of "Encyclopedie Scientifique des Aide Memoire," published under the direction of M. Leaute, Member of the Institute. The author has also written an earlier treatise in the series entitled "Chaleur et Energie," in which he gives an exposition of the fundamental principles of thermodynamics. In the present work he applies these principles, and discusses the theory of perfect gases in a new form, basing it on the laws of Marriotte, Joule and Dalton. Students of thermodynamic theories, who also read French, and handle the calculus with facility, will no doubt find this work an important addition to the literature of the subject of which it treats.

THE ELEMENTS OF ELECTRIC LIGHTING, Including Electric Generation, Measurement, Storage and Distribution. By Philip Atkinson, A. M., Ph.D. 1897; 9th edition, fully revised and new matter added. New York: D. Van Nostrand Co. Cloth; 7½ x 5¼ ins.; pp. 279; illustrated; $1.50.

In his preface the author says:

The object of this volume is to meet the demand for a complete, comprehensive treatise, setting forth the various facts pertaining to electric lighting in plain language, devoid of technicalities and perplexing mathematical formulae. * * * It is also designed as a convenient hand book for the electrical engineer, from which he may refresh his memory. * * * As the storage battery has become an important auxiliary in electric lighting, a full description of its construction, principles and application has been given. * * * New dynamos, chiefly of the multipolar type and designed for heavier work, have taken their place. The latter are here described in full.

Notwithstanding the sweeping claims we have quoted, it is manifest that a book of this size which attempts to cover practically the whole field of electric lighting must do so in a very cursory manner. The author has accomplished his task by barely mentioning many important items and omitting others, quite essential were the volume to be a "complete, comprehensive treatise." The illustrations are, with very few exceptions, of indifferent quality. The book will, however, prove of interest to the general reader, and many engaged in electrical or mechanical work who desire an elementary review of the subject of electric lighting may find it useful.

THE STANDARD ELECTRICAL DICTIONARY.—A popular Dictionary of Words, Terms and Phrases used in the Practice of Electrical Engineering. By T. O'Conor Sloane, A. M., E. M., Ph.D. 1897; 2d edition, revised and enlarged. New York: Norman W. Henley & Co.; 7¼ x 5¼ ins.; cloth; pp. 682; illustrated.

This is a very compact and serviceable book. It is well printed and well bound, and will be of considerable value for ready reference to anyone using electrical language. In fact, the definitions and explanations are so complete we are tempted to say that for general use this dictionary will prove equal to quite a library of special books, and is certainly far more handy.

It is true that the illustrations are at times crude and here and there of no value at all, for example Fig. 224, page 352, representing a magnetic ore separator, and Fig. 268, page 426, representing salient and consequent poles. Now and then the omission of a word will also be noticed, but as a rule essential words and expressions are given with full definitions and explanations.

We would also suggest some alphabetical marking at the top of the pages to facilitate finding words. These points are minor and do not detract to any great degree from the value of the book, a copy of which should be in the possession of every one interested in electrical work.

ANALYTIC GEOMETRY.—For Technical Schools and Colleges. By P. A. Lambert, M. A., Instructor in Mathematics, Lehigh University. New York: The MacMillan Co. Cloth; 5¼ x 7½ ins.; pp. 216; numerous diagrams; $1.50.

The first impression given by this book is a pleasing one, owing to its convenient size, good paper, clear type and sound binding. Unfortunately, in this case, the first impressions are not confirmed as one examines the book.

In our opinion, a text book, especially a mathematical one, should proceed step by step from the less to the greater, so that any student with the necessary ability can follow understandingly the whole book from beginning to end without a teacher's aid. But the author of the work before us apparently has no such idea, for we find in several places new characters and expressions introduced in the discussion with no explanation of their origin and significance. Several of the diagrams are incorrectly drawn and lettered, and some are on too small a scale to be easily read by the student. We may mention as examples Figs. 11, 12, 18, 48, 119 and 130. The language used is at times loose and inconsistent, as an example: in the sixth line of the explanation of Fig. 119 the word "minor" should be major and at the same time the figure is only half drawn. On page 25 the description and lettering do not agree, while on pages 102 and 103 will be found figures 90 and 91 nicely lettered but, so far as we can find, not mentioned in the text. On page 27 a problem is given whose solution depends upon the elliptic compass, but this instrument is not described until page 127.

JOHNSTON'S ELECTRICAL AND STREET RAILWAY DIRECTORY FOR 1897.—Containing Lists of Electric Light Plants, Street Railways, Telegraph Companies, etc. New York: The W. J. Johnston Co. Cloth; 9¼ x 6½ ins.; $5.

For some years this directory has appeared regularly. It contains lists of central electric lighting stations, isolated plants, mining plants, street railways (electric, horse and cable), telegraph companies, district messenger companies, telephone companies, manufacturers of and dealers in electrical and street railway apparatus, machinery and supplies. The book fills a very useful place in a fairly satisfactory way, although its publishers introduce a number of features which if eliminated or corrected would increase the convenience of the book. A directory should be arranged so that its contents will be accessible with the least possible expenditure of time and effort on the part of the reader. In other words, the arrangement, headings, page numbering, etc., should be prominently placed so as to strike the eye, and ought not to be on the binding edge of a page. There is also a feeling when examining the book that thinner paper, smaller type and a more compact arrangement would make an improvement in bulk and price, which would be appreciated by those needing the information contained. There is no question, however, but that the directory contains much that cannot fail to be of interest and service to those engaged in electrical or allied industries or professions. This is especially so since it is now the only electrical directory published in the United States.

THE SANITARY CONDITION OF THE BROOKLYN WATER SUPPLY.—Report of the Rockville Center Laboratory of the Department of Health of the City of Brooklyn to Z. Taylor Emery, M. D., Commissioner of Health. By Hibbert Hill, M. B., Biologist and Director, and Joseph W. Ellms, Chemist. E. H. Wilson, M. D., Consulting Bacteriologist. Paper; 6 x 9 ins.; pp. 177 and many tables in addition, unpaged. Address Brooklyn Health Department.

This laboratory was established in October, 1896, and the report is dated Dec. 1, 1897. The laboratory was located as nearly as possible at the center of the drainage area and the samples were collected in a covered two-horse wagon, generally reaching the laboratory within three or four hours after they were secured. Chemical, bacterial and microscopical examinations were made contemporaneously and physical inspections of the subsidiary drainage areas were made as far as possible. The rainfall records were also studied in order to determine the effect of rainfall upon the composition of the water, especially upon its color, albuminoid ammonia and bacteria.

Some idea of the magnitude of the work can be conveyed by the statement that it covered some 17 ponds and reservoirs and about a dozen driven well stations. The practical outcome of the investigation are the recommendations, among other things, that certain of the ponds and wells be abandoned as dangerous on account of sewage pollution; that others be looked upon as suspicious; that vigorous measures be taken to prevent the pollution of the water supply; that the practice of keeping close track of all typhoid fever in the drainage area and of disinfection where cases occur be continued; and that further studies of the quality of the supply be made with a view of erecting purification plants where needed or securing an additional supply so that dangerous sources may be cut off.

The authors of the report believe that this investigation is one of the most notable examples of simultaneous chemical and bacterial studies of a water supply, extending over a long period. While they recognize the limitations of bacterial examinations of natural waters they believe that taken in conjunction with chemical and meteorological conditions and a visual inspection of the drainage area bacterial determinations may be of great value. We commend the report to those interested in this phase of water examination, as well as to all who are making a study of the sanitary character of public water supplies.

The Brooklyn water supply is also being studied at another laboratory, established in 1897 by the Department of City Works, under the direction of Mr. I. M. de Varona, M. Am. Soc. C. E., Engineer of Water Supply, with Mr. Geo. C. Whipple, as Biologist-in-Charge. Since the above was written we have been informed that the Health Department Laboratory has been closed.

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