ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

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AN ACT TO PREVENT THE POLLUTION OF PUBLIC water supplies was passed by the legislature of the State of Washington at its recent session. The act extends the jurisdiction of towns and cities over all property devoted to public water supplies, whether under public or private ownership; makes water pollution unlawful wherever the purity of the public supply is destroyed or endangered, declaring it to be a nuisance punishable on conviction by fines in any sum not exceeding $500; provides that if nuisances are not abated within one day after proof, or such time as the court may fix, a warrant shall be issued to the county sheriff and that he shall forthwith abate the nuisance, the expense involved to be added to the costs against the party maintaining the nuisance. The act also makes it the duty of the officer or officers in charge of the sanitary condition of each town and city to enforce the act, and authorizes municipalities or companies owning public water supplies to secure injunctions against the maintenance of nuisances as above. We are indebted to Messrs. Neal Chatham and D. B. Garrison, State and Deputy State Auditors, respectively, for a copy of the act.

A PLAN FOR INCREASING THE CAPACITY of gravity water mains was suggested in a paper read before the last meeting of the Municipal and County Engineers by Mr. J. B. Wilson, Assoc. M. Inst. C. E., Surveyor to the Rural District Council, Cockermouth, England. It is a common practice in England to provide "compensation water" to riparian owners below impounding reservoirs. Mr. Wilson suggests that as this water passes from the dam down the stream there is a great waste of power, which might be utilized by means of a hydraulic motor to drive a pump, and thus increase the carrying capacity of the main. He thinks that centrifugal pumps and screw propellers excel all other types of pumps for this purpose. The paper in question was very brief, occupying less than a column of the London "Contract Journal," to which we are indebted for this note.

THE CLEVELAND WATER-WORKS TUNNEL HEADing, from the first lake crib towards the shore, has met the original heading from the shore cribward, near the point where the two explosions occurred about a year ago.

THE STRUGGLE FOR MUNICIPAL OWNERSHIP of street railways in Detroit entered upon a new stage immediately after the decision of the State Supreme Court that the act providing for the purchase of railways by the city was unconstitutional. The new scheme was to organize a private company, in behalf of the city, to buy the railways, with the understanding that five tickets would be sold for 15 cts. As the franchises for some of the lines expire soon it was proposed to grant a new franchise making all previous ones expire 48 years from date. Lest a provision for 3-ct. fares should make it difficult to finance the "Detroit Municipal Railway," as the new company was called, the first franchise was to provide for six tickets for 25 cts. After bonds had been issued a new franchise providing for 3-ct. fares was to be granted. The first franchise was to be a "security franchise" and the second a "working franchise." The "security franchise" passed one branch of the city council, but adverse public opinion made it apparent that the ordinance could not be passed over the expected veto of the mayor, and the street railway company withdrew its offer to sell. The popular belief seems to have been that through failure to pay expenses with 3-ct. fares, or for some other reason, the net result of the scheme would be a long extension of franchises, with the old rates of fare still in force. Gov. H. S. Pingree was one of the incorporators of the new company. During the agitation street railway fares were reduced to 3 cts. when five tickets were bought, but the right was reserved to exact the old fare from holders of these tickets.

A SMOKE CONSUMING SYSTEM has been recently tried at Berlin, Germany, with results which are favorably reported on by Consul General Mason. It consists in the use of perforated hollow grate-bars in connection with grate-bars of the ordinary pattern and forcing air into these hollow bars by a fan blower. The air is heated in a manifold connecting to each of the hollow bars and issues in a series of fine jets at a high temperature. It is said that cheap grades of fuel are burned in this way with little smoke. The invention is covered by U. S. patent No. 613,359, issued Nov. 1, 1898, to Paul Cornelius, of Berlin.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head collision on the Norfolk & Western R. R. at Haverhill, O., July 18. A fast freight train and a passenger train collided on a curve, during a heavy fog. Three trainmen were killed and another was injured.——Another serious accident was a head collision on the New York, New Haven & Hartford R. R., at New Haven, Conn., July 17. The westbound Washington "Colonial Express" ran into an eastbound Air Line passenger train, under the Fair St. bridge. A yard switchman reported that he was responsible, having thought he could switch the eastbound train across the track before the express train was due. Both engines were badly damaged, and the baggage car of each train was telescoped by the tender. Nobody was seriously hurt.

ANOTHER DRAWBRIDGE ACCIDENT occurred at Chicago, July 13, at the Chicago & Northwestern Ry. bridge over the Chicago River at Kinzie St. A steamer had just cleared the draw, when a train of seven empty cars was backed down, and two cars went into the river, the brakemen escaping by jumping. The end brakeman had a hose and valve attached to the brake pipe to enable him to control the train, but the brakes refused to act, and when he discovered this it was too late for the hand brakes to be of use. The cars were raised by means of a wrecking crane.

A FIRE IN THE POWER HOUSE of the Niagara Falls water power plant at Niagara Falls, N. Y., was caused July 15 by the short circuiting of the current. One of the transformers, the one for the street railways, was burned out, and the flames set fire to a tank of oil. Cars were stalled for two hours.

DISTORTED RAILS, due to the extreme heat and insufficient joint spacing, caused the derailment of a work train near Glasgow, Mont., on the Great Northern Ry. July 16. Five men were hurt.

THE OIL TANK STEAMER "Maverick," of the Standard Oil Co., was burned at Halifax, N. S., July 17. It was a screw steamer, 239 ft. long and 36 ft. beam, of 1,516 tons, built by the Columbia Iron Works, Baltimore, Md., in 1892. The tanks exploded, bursting the hull, and the vessel went down. One man was badly hurt.

TRACK ELEVATION at Columbus, O., has been reported upon by Mr. Griggs, City Engineer. The total cost of the work is estimated at $717,049, of which the city would pay $187,478 for changes in streets, etc.

THE NEW FREIGHT YARDS of the Illinois Central R. R. at New Orleans, La., will be completed in a few weeks. They will have about 48 miles of track, with accommodations for 3,600 cars, and ample allowance has been made for extensions. South-bound trains will enter a receiving yard of 500 cars capacity, whence the cars will be sent by gravity to two distributing tracks of 832 cars capacity each. The yards occupy a tract of ground half a mile wide and three miles long, the yard tracks being almost at right angles with the main tracks. The lead track is approached by a 6° Y from the main tracks. There will be a 40-stall round house, 40-pocket coal chute, cinder pit, sand tank, water tanks, ice house, stock yard, etc., and a caboose track for 36 cars.

A NEW STONE DRY-DOCK at the Brooklyn navy yard will probably be built, to replace the timber dock which was damaged by a heavy storm on July 13. It had been decided to build a fourth dry-dock at this yard, but this will probably be abandoned, the new dock being made the largest in the yard. The Secretary of the Navy will apply to Congress for the necessary authority for this change in plan. The new dock would cost about $1,500,000 and require about two years for construction.

THE TWIN SCREW STEEL STEAMSHIP "Chester W. Chapin" was launched at the yards of the Maryland Steel Co., at Sparrow's Point, Md., on July 11. The vessel is to cost $500,000 and is designed to have a speed of 21½ statute miles an hour. Her principal dimensions are: 324 ft. on deck, 310 ft. on the water line, 64 ft. breadth over guards, and 17 ft. 2½ ins. depth. Two surface-condensing triple expansion engines with cylinders of 24, 38 and 60 ins. diameter by 30 ins. stroke will furnish the power. These engines are expected to develop 4,200 I. HP., steam being supplied from six Scotch boilers 13 ft. in diameter by 11½ ft. in length, at a working pressure of 160 lbs. The boilers will have three steel corrugated furnaces, 400 sq. ft. of grate surface and 12,000 sq. ft. of heating surface. The crank shaft will be of the built-up type. The steamer is expected to make her contract speed on a draft of 10 ft. 6 ins. There will be steam heat throughout the vessel, which will be fitted with two iron water tanks of 2,000 gallons capacity each. An electric plant will supply currents to 650 16-candle power incandescent lights and an 8,000-candle power search light. The vessel is being built for the New York & New Haven Line, and the contract calls for her delivery on Sept. 3, 1899.

SUITS FOR DAMAGES AGGREGATING nearly $1,000,000 have been brought against the State of New York on account of the State canals improvement work done under the $9,000,000 appropriation, according to a report recently made by the Attorney-General. These claims for damages are apportioned to each canal as follows: Erie Canal, western division, $255,957; Erie Canal, middle division, $408,527; Erie Canal, eastern division, $141,260; Oswego Canal, $5,243; Champlain Canal, $76,708; total, $887,727. Since this list was prepared claims for damages amounting to $60,000 have been presented. In all there are about 600 claims for damages, and the Attorney-General has organized a special corps of lawyers to investigate the claims for damages and protect the State's interest before the Court of Claims. Among the claims is that of the Grand Trunk Ry. for $31,000; the Buffalo Dredging Co., $10,000; the Empire Portland Cement Co. for $27,848; the Onondaga County Savings Bank, $15,000, and Edward Joy, of Syracuse, $10,500. The Syracuse claims are due to damage caused by a break in the Erie Canal.

A LARGE CONTRACT FOR MOTOR CARRIAGES is reported as having been placed by the Electric Vehicle Co., of New York. The contract is for 4,200 vehicles, involving an expenditure of $8,000,000, and it will include about 4,000 hansoms, broughams and other passenger carriages, and 200 delivery wagons. The batteries will be built by the Columbia Automobile Co. (which has exclusive rights from the Electric Storage Battery Co. for batteries for vehicles); the motors by the Siemens & Halske Electric Co., of Chicago; the bodies by the Studebaker Carriage Co., of South Bend, Ind., and the other work by the Columbia and Electric Vehicle companies.

THE CHINESE RAILWAY SYSTEM, as composed of various projected lines, will be of some considerable importance, and a statement has been issued by the Bureau of Statistics of the U. S. Treasury Department regarding these lines. The Canton & Hankow line, which the American syndicate has agreed to construct, and which agreement it is now asking the Chinese government to confirm, stretches northward from Canton to Hankow, the principal interior city of China, some 600 miles. A Belgian syndicate has a concession for a line from Hankow north to connect with the existing line reaching Peking, the capital of China. The American syndicate has an option for the right to construct this Hankow-Peking line providing the Belgian syndicate omits to take advantage of its concession. From Peking a line will connect with the Manchurian extension of the Trans-Siberian Ry., which is now under construction to Port Arthur, thus making a great system which will stretch from St. Petersburg to Canton, on the coast of China, a distance of about 9,000 miles. From Canton westward, British interests have projected railway lines to the southwestern extremity of China, where they will connect with the present railway system of Burmah, and in turn with that of India. From the western terminus of the Indian railway lines at Karachi to the point in Persia toward which Russian engineers are now pushing surveys for railway lines is but a few hundred miles, a gap easily filled whenever British interests find it advantageous to encourage direct railway intercourse between India and the railway systems of southern Europe. Over 3,000 miles of railway are now projected in China, over 3,000 miles of telegraph are in operation, and by recent action of the Chinese government the waterways of China have been opened to foreign vessels and commerce. The natural waterways of China aggregate about 10,000 miles, and form the most important means of internal communication at the present time.

TWIN TIDE GATE FOR THE SWANSON STREET CANAL OUTLET, PHILADELPHIA, PA.

By Harrison Souder, Civil Engineer.

That portion of Philadelphia, Pa., lying south of Porter St., between the Delaware and Schuylkill rivers, known locally as "the Neck," covers an area of some six square miles, the surface of which is, in general, 3 to 4 ft. below the level of high tide in the rivers. These mud flats, together with those on the west side of the Schuylkill, have been famous as hay and truck farms from early Colonial times. In fact, to protect these low lands from the tides, so as to insure the annual crops, Meadow bank companies were formed as early as 1760, under charters granted by King George II. These companies were empowered to build dikes, dams and sluices, or tide gates, and they had the right to collect taxes from the landholders to pay for the maintenance of these structures. The dikes were all built of river mud, an excellent material for the purpose. Most of the old sluices were constructed as follows: A sluice-box, 2 ft. × 8 ft., was built and provided with hinged flap doors, or gates. A place for the sluice was excavated in the dike, and four rows of sheet piles, 2 ins. thick by about 3 ft. long, were driven into the mud in the form of an oblong of the required size. The sluice-box was then floated in and settled down upon the sheet piles and mud. The dike was then rebuilt over the sluice and the work was finished. The sheet piles were simply to prevent musk rats from boring under the box. Some of these sluices have been in operation for over 20 years, it is said, and still give good service. They were, however, too small to permit the heavy rainfalls to flow away quickly enough to prevent damage to the farm lands.

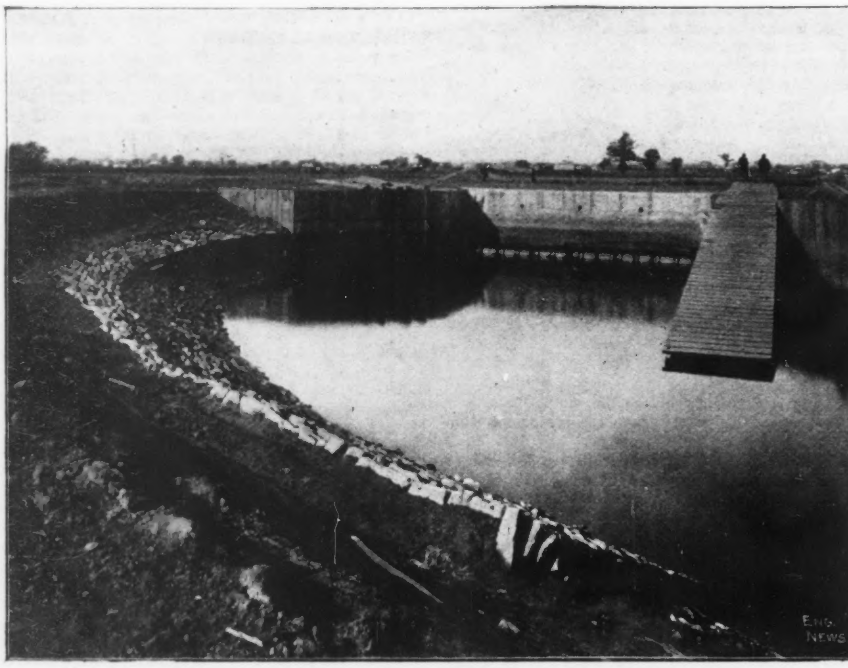

FIG. 4.—VIEW OF SWANSON ST. CANAL TIDE GATE FROM RIVER SIDE, SHOWING GATES OPERATING AGAINST A RISING TIDE.

To remedy this a waterway, known as the Swanson St. Canal, and having a trapezoidal section 22 ft. wide on the bottom, and about 7 ft. deep, with side slopes 1 on 1½, was built early in the '70's. A large outlet sluice was built to drain this canal. In 1896 it was decided to enlarge the canal and build a second sluice alongside the old one, and then to take the old one out and put a new one in its place. This work was completed in the summer of 1897.

The new sluices were modeled closely after the old sluices, but were placed on several rows of 4 ft 6 ins. and 12 ft. long sheet piling. Shortly after completion, unusually high tides, probably aided by musk rats, wrecked a part of the dike and one of the sluices, and flooded the meadows. The late Carl A. Trik, C. E., Superintendent of Bridges for the city, designed new sluices to take the place of the wrecked ones, just before his death. They were built under the supervision of the writer, who was at that time Acting Superintendent of Bridges. Mr. Trik's design called for twin sluices, 2 ft. × 18 ft. each, a total waterway of 72 sq. ft. The old sluices were entirely removed. The material from the old boxes was found to be in good condition, and was used in the new work.

By driving test piles it was found that the gravel bed underlying the mud would be reached at about 30 to 35 ft. depth. Round piles were driven 6 to 7 ft. centers and capped with heavy timbers, on which was laid a floor of yellow pine planks. Surrounding this platform was built a tight permanent cofferdam of 6 × 12-in. yellow pine, tongued and grooved sheet piling, spiked to waling strips. Two lines of sheet piles were driven in front and back and one line on each side. The interior of this dam was packed with well-puddled mud, which was allowed to settle several months before the floor above mentioned was laid on top, as indicated, care being taken to get a tight contact between the mud and the planks. The front and rear sheet piles were cut off at the level of the bottom of the outlets; the side sheet piles at the level of the top of the boxes. This construction is well shown on the plans, Figs. 1 and 2.

On top of the platform, and between the sheeting, was laid 2 ft. of concrete, in proportions of 1 part of Portland cement, 3 parts of sand, and 5 parts of stone, which would pass a 1½-in. ring. On the concrete were built the sluice boxes. Two white oak arch-shaped lintels were bolted over each end of the sluice boxes, and concrete retaining walls were built over these. These front and rear walls were tied together by three 1½-in. round iron rods. Wing walls of 4 × 12-in. sheet piles spiked to wale strips and braced with round piles, were built at the corners and carried into the dike, as shown by the drawings. The gates, Figs. 2 and 3, were yellow pine with wrought iron hinges, and were inclined at an angle of 30°. The gate seats were faced with copper and the gate-bearings with rubber gaskets.

Iron bars form a grating at the inner end of the sluice, and a small platform, supported on angle irons, and reached by an iron ladder, gives access for cleaning away rubbish. The river end of the sluice-box extends some 3 ft. beyond the retaining wall, forming a platform giving access to the gates. The platform foundation extends beyond the gates 8 ft., forming an apron, which prevents scour. Rip-rap is spread in front of the apron.

The outer dikes on curves are faced with rubble stone, Fig. 4. Small box sluices of simple design were built through the inner dikes to drain the footing ditches. Fig. 4, from a photograph, shows the sluice finished and in operation. Since constructed the sluice has given no trouble, and rapidly drains the low dictricts reached by the canal. A boat runway constructed over the sluice, gives access to the canal for light boats. The approximate quantities of materials used in construction of this work were as follows: 150 yellow pine piles, 12 ins. diameter; 128,000 ft. B. M. yellow pine lumber; 1,152 ft. B. M. white oak lumber; 1,200 lbs. iron rods, etc.; 274 cu. yds. concrete, and 7,800 cu. yds. of excavation and refill over sluice and on dikes.

The cost of the work was as follows:

Contract price	$15,920
Additional work—ladder, bracket platform, etc.	310
Cost of sluice	$16,230
Slope paving, 375 sq. yds.	244
Dredging and excavating canal, 492 cu. yds.	98
Total cost of work.	$16,572

The contractor was Mr. Edward F. Fonder, of Philadelphia, Pa., and the Inspector was Wm. Banks.

UNDERGROUND ELECTRICAL CONSTRUCTION.*

By Louis A. Ferguson.

In the early 80's, among the first underground systems, there was developed by the Edison Company a two-wire system adapted for low-tension distribution at 110 volts. The system was made up of tubes, so-called, consisting of iron pipes in lengths of approximately 20 ft., in each of which were placed two half-moon shaped copper conductors, separated from each other by asphaltum.

The rapid growth of the lighting business rendered the use of the two-wire system for low-tension distribution purposes of limited value, and the advent of its successor, the three-wire system, brought forth the design of the three-wire Edison tube system, now so extensively used in all of the large cities of this country. Owing to the very important part which this system has played in the development of electricity in the large cities, and because of its permanency, so conclusively proven by its continued use for so many years, any description of underground electrical construction is incomplete without a mention of its design and its value as a component part in the most stable and profitable branch of applied electricity is amply justified.

The Edison three-wire underground tube system was most carefully thought out in every detail by its designers and forms a complete network of underground conductors, all of its parts thoroughly interchangeable and capable of the greatest flexibility, both in construction and in operation. The conductors are made in much the same manner as the early Edison two-wire tube, except that three round copper rods are employed in place of the two half-moon conductors. Each copper rod is sufficiently wound with a jute cord to afford mechanical separation between the conductors themselves. The rods are then placed in an iron pipe and are further insulated from each other by asphaltum, the tubes being plugged at each end with hard rubber. These tubes are made in lengths of 20½ ft., and are laid in the ground, coupled together by means of flexible stranded copper couplings, enclosing which is placed an oval coupling box, and in which is poured asphaltum compound for insulating the joints and rods one from another and from the ground. Being laid in lengths of 20 ft., it affords a ready connection to each building, service boxes in the shape of a "T" being used whenever connections to the buildings are made from the main.

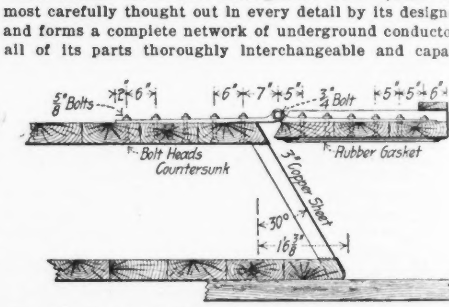

Fig. 3.—Detail of Flap Gate for Swanson St. Canal Tide Gate.

At each intersection these tubes enter a cylindrical cast-iron junction box, in which is placed three copper rings, to which are connected the three copper conductors of each main by means of fusible safety links. These junction boxes are fed by feeders directly from the central station, the feeder tubes in the original system being of the same general type as the main tubes, the difference

*Abstract of a paper read before the National Electric Light Association at its 22d annual meeting, held at New York city, May 23-25, 1899.

TABLE I.—Cost of Labor, Fittings and Paving for Laying One Length Edison Main Tube in Streets with Various Pavements.

Kinds of pavement.	Sizes—Circular mils. 500,000	400,000	350,000	250,000	200,000	100,000
Unimproved, no paving	$6.71	$6.71	$6.71	$6.08	$5.66	$5.45
Macadam	8.50	8.50	8.50	7.75	7.46	7.25
Cedar	10.17	10.17	10.17	9.43	9.02	8.11
Cedar reserved	13.64	13.64	13.64	12.89	12.59	12.38
Granite	12.48	12.48	12.48	11.74	11.44	11.23
Granite reserved	22.12	22.12	22.12	21.36	21.07	20.85
Asphalt	29.81	29.81	29.81	29.18	28.77	28.56
Cost of one length tube	$34.73	$30.26	$28.28	$15.88	$18.36	$9.68

being that one of the conductors which is used as a neutral in the feeder has ⅓ the cross-section of each of the other conductors. In each of the feeder tubes is also placed three small pressure wires, which are connected to the rings of the junction boxes in which the feeder terminates, the station end of the pressure wires being connected to a voltmeter, which indicates the pressure or voltage at the feeder end in the junction boxes.

The mains are made in all sizes from 250,000 to 500,000 circular mils, and the feeders in sizes from 250,000 to 1,000,000 circular mils. Special feeders have been built with one conductor in each tube running as large as 3,000,000 c. m. Table I. gives the cost of the tube, labor, fittings and paving in laying one length of main in various sizes from 100,000 to 500,000 c. m. in streets with various pavements.

In European countries the underground system of distribution, until recently, has almost universally employed cables laid directly in the ground, the cables being insulated either with paper or rubber, covered with lead, the lead covering being asphalted, served with jute and impregnated with asphaltum, the jute and asphaltum acting as a preservative to the lead.

The methods of coupling cables and the installation of services are similar to those described for the Edison underground system, as used in this country, the copper couplings being adapted for the use of cables instead of rods.

The experience of European central stations shows that very little trouble is encountered by the development of short circuits in cables, and the cost of repairs is exceedingly small. It has been supposed by many that the cost of maintaining Edison tube systems for mains was excessive, and that troubles from short circuits and grounds were too frequent in this country, and some companies have been led to consider seriously the use of duct systems, employing cables for both feeders and mains in their distribution system.

While the writer believes that the Edison tube is not desirable for feeders on account of the excessive loads which they are obliged to carry at the "peak" of the load, and also in some cases for many hours in the day, it certainly is a fallacy that cables should be generally employed for mains in the place of Edison tube, as may be proven by reference to the actual cost of repairs and renewals on these tube mains. While it is undoubtedly true that in any system employing cables throughout, both for feeders and main, the probability of short circuits and grounds will be exceedingly slight, as compared with those employing Edison tubes, the additional cost of the interest on the investment in case a cable system is used for mains, as well as feeders, will more than offset the cost of repairs and renewals when Edison tubes are used for mains and cables for feeders.

An analysis of the cost of repairs and renewals of the low-tension underground system of a large central station company, where approximately 90% of the low-tension underground investment is made up of strictly Edison tube installation, shows that the maintenance cost of mains and feeders represents an extremely small annual percentage of the value of the total investment; so small, in fact, that it readily explains why the company, even in laying new mains, is reluctant to abandon its original method.

A conservative estimate of the additional outlay required to install a cable conduit system over that of the Edison tube system for mains, but not including feeders, would be, in densely settled territories, from 33½ to 50%. The total annual cost of supervision and maintenance of the low-tension underground system referred to is 1.9% per annum of such total underground investment, the division of the costs being shown in Table II.:

TABLE II.—Annual Cost of Supervision and Maintenance of a Low-Tension Underground System.

Item.	Per cent. of entire investment.
Office	0.093
Distribution	0.140
Junction box and testing feeder mains	0.092
Cleaning and filling manholes	0.075
Purchase of tools and repairing	0.121
Repairs on trunk line	0.109
Repairing of mains	0.180
Repairing of feeders	0.332
Repairing of service wires	0.085
Repairing of junction boxes	0.056
Repair to manholes and conduits	0.222
Routine operating	0.056
Miscellaneous expense	0.019
Paving	0.182
Paving inspection	0.026
Watching company's lines	0.060
Labor for renewing mains	0.075
	1.91

It will be seen by carefully considering these items that some are incident to the conduit system, which has been installed to some extent during the past few years. The paving charges could safely be distributed between feeders, mains, service and junction boxes in the proportion of their various expenses, and the inspection charge could also be distributed in a similar manner. The percentage charge for labor for renewing mains represents that expended in replacing with larger mains those which have become too small to safely carry the business connected, and the cost of the material for the new main may be charged against investment, the value of the old mains being credited to investment, which is a proper and conservative method.

If we take, in the list of costs above stated, the items for trunk lines, feeders, mains, services, junction boxes, one-half the tools, one-half the routine operating, one-half the miscellaneous, two-thirds of the watching of lines and the renewals of mains as representing the true charges against the cost of maintenance of a purely Edison tube system, we find that the annual maintenance charge is 1.27%. Assuming, then, that all of these items, amounting to 1.27%, would be eliminated from the maintenance cost in case a cable system were used, we would then have a maintenance charge for the cable and conduit system of 0.64% per annum. To this must be added the interest charge at 5% on the 33½% additional investment required for a cable and conduit system, which would

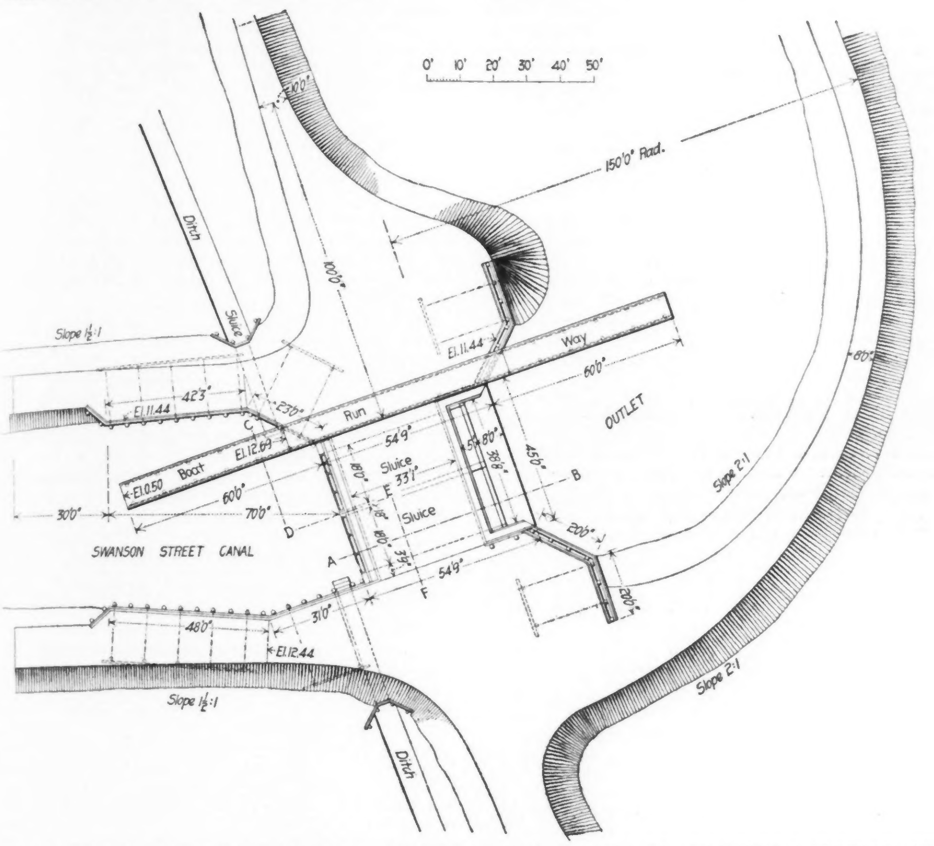

FIG. 1.—PLAN OF SWANSON ST. CANAL OUTLET, PHILADELPHIA, PA, SHOWING LOCATION OF TWIN TIDE GATE.

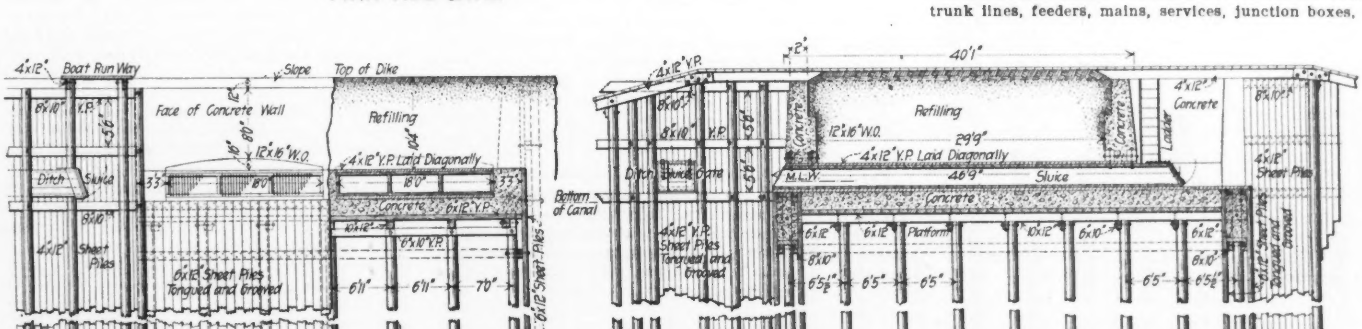

FIG. 2.—TRANSVERSE AND LONGITUDINAL SECTIONS, SHOWING TIDE GATE CONSTRUCTION, SWANSON ST. CANAL.

amount to 1.66% per annum, making a total annual maintenance charge of 2.3% for the cable and conduit system.

Notwithstanding the greater increase in the original investment, most of the large central station companies have abandoned the use of Edison tube for feeders, and are now employing cables drawn into ducts on account of the additional ampere capacity per 1,000 circular mils gained thereby, and the advantage of quick repairs, reliability of service, minimum trouble from short circuits, due to grounds, overloading and moisture, together with the additional permanency which is gained by the use of cable and conduit system. With the same section of copper it is possible to carry on a cable feeder, without permanent injury, a larger load than may be carried in a tube feeder, since the insulating compound of the tube has a low melting point, and the contact surface of the flexible joint is too small, when it is considered that the joint is soldered with a composition of low conductivity and made by workmen who are not always over careful. Most of the break-downs and trouble which have occurred on Edison tubes have arisen from the joints, the solder becoming melted and the settling of one tube pulling the joint apart and opening the circuit. This limited carrying capacity of Edison tube feeders, together with the uncertainty of their operation, has been the most potent influence in displacing feeder tubes by cables drawn in ducts.

Table III. gives what is now approximately the standard practice regarding thickness of insulation and lead wall, for both paper and rubber covered cables for central station work employing 500 volts and under:

TABLE III.—Thickness of Insulation and Casing of Feeder Cable.

	Insulation					
	Rubber			Paper		
		Thickness			Thickness	
Size, c.m.	No. of strnds.	Wall, in.	Lead, in.	No. of strnds.	Wall, in.	Lead, in.
250,000	19	3-32	1-16	19	4-32	1-8
350,000	37	7-64	5-64	37	5-32	1-8
500,000	61	4-32	3-32	61	5-32	1-8
750,000	61	9-64	3-32	61	5-32	1-8
1,000,000	61	9-64	3-32	61	5-32	1-8
1,500,000	91	11-64	1-8	91	6-32	1-8

The first companies to use conduit in this country were those operating high-tension series arc and alternating current systems. Among the first conduits to be used was the old Dorset conduit, made up in multiple ducts, and laid directly in the ground. These ducts never proved successful and were later substituted by pump-log ducts, which, though very cheap, were found to deteriorate rapidly and gave a great deal of trouble by catching on fire when a burn-out took place in the cable. This conduit has given way to fireproof ducts made of cement, vitrified clay tile and iron ducts with cement lining.

Table IV. shows the costs per duct ft. of various types of conduit laid in various types of pavements, the figures being computed upon a uniform price of 10½ cts. per lin. duct-ft. for ditching and laying of conduit, including cement concrete.

TABLE IV.—Total Cost, in Cts. per ft. of Duct Laid, of Underground Conduit of Different Kinds.

Kind of Pavement.	No. of ducts in groups: 2 or 4.	6 or 9.	12, 16 or 20.	25 or 30.	40, 50 or 60.
National Conduit.					
No pavement	16.74	16.74	16.74	16.74	16.74
Cedar	22.81	19.27	18.07	17.56	17.31
Cedar reserve	26.86	20.95	18.94	18.11	17.69
Granite	26.86	20.95	18.94	18.11	17.69
Granite reserve	36.99	25.17	21.14	19.49	18.64
Macadam	21.46	18.70	17.77	17.38	17.18
Asphalt	57.24	33.61	25.55	22.24	20.56
Francis Conduit.					
No Pavement	14.66	14.66	14.66	14.66	14.66
Cedar	20.73	17.19	15.99	15.48	15.23
Cedar reserve	24.78	18.87	16.86	16.03	15.61
Granite	24.78	18.87	16.86	16.03	15.61
Granite reserve	34.91	23.09	19.06	17.41	16.56
Macadam	19.38	16.62	15.69	15.30	15.10
Asphalt	55.16	31.53	23.47	20.16	18.48
Camp Tile.					
No pavement	14.14	14.14	14.14	14.14	14.14
Cedar	20.21	16.67	15.47	14.96	14.71
Cedar reserve	24.26	18.35	16.34	15.51	15.09
Granite	24.26	18.35	16.34	15.51	15.09
Granite reserve	34.39	22.57	18.54	16.89	16.04
Macadam	18.86	16.10	15.17	14.78	14.58
Asphalt	54.64	34.01	22.95	19.64	17.96
Lithocite Conduit.					
No pavement	15.18	15.18	15.18	15.18	15.18
Cedar	21.25	17.71	16.51	16.00	15.75
Cedar reserve	25.30	19.39	17.38	16.55	16.13
Granite	25.30	19.39	17.38	16.55	16.13
Granite reserve	35.43	23.61	19.58	17.93	17.08
Macadam	19.90	17.14	16.21	15.82	15.62
Asphalt	55.68	32.05	23.99	20.68	19.00
3-in. Iron Pipe.					
No pavement	25.5	25.5	25.5	25.5	25.5
Cedar	31.57	28.03	26.83	26.32	26.07
Cedar reserve	35.62	29.71	27.70	26.87	26.45
Granite	35.62	29.71	27.70	26.87	26.45
Granite reserve	45.75	33.93	29.90	28.25	27.40
Macadam	30.22	27.46	26.53	26.14	25.94
Asphalt	66.00	42.37	34.31	31.00	29.32

The cost of ditching and repaving will vary in different cities, according to the class of soil and according to the method employed by the city in letting contracts for the maintenance of the pavements. The cost of repaving is, however, much the same in different cities and averages about as follows:

	Per sq. yd.
Cedar	$0.45
Cedar reserve	0.75
Granite	0.75
Granite reserve	1.50
Macadam	0.35
Asphalt	3.00

The system of underground distribution now almost universally adopted by large central station companies employs cables drawn into ducts for the feeders and Edison tube for the mains. The conduit consists of from 6 to 30 or more ducts laid in cement concrete, the top tier being about 2 ft. below the top surface of the pavement. At each street intersection the conduit system enters a manhole which is built up of a 9-in. brick wall, the dimensions of the manholes varying according to the number of ducts and the importance of its location. The roof of the manhole is built up of steel beams, with brick arches, cast-iron frame being laid in the pavement to provide for supporting the manhole cover, which is punctured with circular openings to admit of the exit of gas and entrance of air. The bottom of the manhole is concrete and is connected to the sewage system of the city, backwater traps being provided to prevent the backing up of sewage into the manhole. The conduit system with its manholes thus constructed forms a part of the sewerage system of the city and any water which enters the manholes from the street drains off to the sewer, and free circulation of air from one manhole to another is obtained through the ducts.

In these manholes are placed junction boxes in which cable feeders terminate. Edison tube mains project through the wall of the manhole and their ends are connected by means of cables to the terminals in the junction boxes, connections between terminals and the bus-bars of the junction boxes being made by copper safety fuses.

All feeders are drawn in lengths of from 400 to 600 ft., and are connected in the manhole by means of feeder coupling boxes. This coupling box is made of iron, with hinged cover with bushed entrance for the cables, terminals inside being connected together by means of copper bar links.

Table V. shows the cost of construction of manholes of various dimensions in different types of pavement:

TABLE V.—Total Cost of Different Sizes of Manholes Inclusive of Cost of Repavement.

Size in ft.	Cedar.	Cedar reserve.	Granite.	Granite reserve.	Macadam.	Asphalt.
2 × 3 × 3	$32.18	$32.94	$32.94	$34.83	$31.92	$38.63
3 × 3 × 4	42.52	43.46	43.46	45.80	42.21	50.48
3 × 4 × 4	49.21	50.32	50.32	53.10	48.84	58.67
4 × 4 × 4	55.45	56.78	56.78	60.08	55.01	66.70
4 × 5 × 5	67.05	68.58	68.58	72.44	66.54	80.08
5 × 5 × 5	111.67	113.50	113.50	117.94	111.13	126.82
6 × 6 × 6	136.57	138.87	138.87	144.60	135.81	156.08
6 × 7 × 6	146.62	149.19	149.19	155.63	145.76	168.50
7 × 7 × 7	164.38	167.27	167.27	174.47	163.42	188.89
8 × 8 × 8	194.65	198.19	198.19	207.03	193.48	224.72

In conduit systems one of the greatest difficulties experienced is with gas which leaks into the manholes, sometimes from the sewer, but generally from the illuminating gas pipes which have been laid for years in the streets in our large cities. In New York city the leakage is so great that explosions are avoided and conduit manholes rendered accessible only by maintaining an air pressure slightly in excess of the atmospheric pressure throughout the conduit system. This is accomplished by compressing stations, which are maintained at a large expense and which are indispensable, since no natural system of ventilation would be sufficient. In other cities, such as Chicago, where the leakage is by no means as great as in New York, the manholes are constructed, as I have before described, connected with the sewer system of the city, and a natural means of ventilation is employed.

The manhole covers are perforated and a slight pitch is given to the duct line between manholes, and explosions are of very rare occurrence. In winter time, however, it is necessary to keep the manhole covers free from frozen snow, as the latter prevents ventilation and allows the collection of gas in the manholes, which may produce an explosion from short circuits or other causes.

Owing to the perforations in the covers of the manholes the manholes are receptacles for dust and dirt and require constant cleaning to keep the sewer connection free and to permit working on the cables, which is a source of expense avoided in systems employing sealed manholes.

A conduit system, which might be termed a compromise between the Edison tube and the ordinary conduit system, is one which has been used to some extent in this country and is known as the Cummings duct. This duct consists of iron pipe in which is placed a wooden duct made with any number of openings, the pipe being coupled in much the same manner as is done in the Edison tube mains. Bare copper cables are drawn through these ducts and are connected in a junction box similar to that of the ordinary Edison tube system.

In the town of Hove, near Brighton, England, bare copper bars are laid in the ground on porcelain insulators in a wooden trough directly in the ground. The system covers a limited area and it is doubtful whether it would be practicable in large cities of this country, where streets are subject to heavy traffic and are torn up at such frequent intervals.

The sewers of Paris are used as subways for electric conductors, the companies using the subways paying rental to the city. Service connections are made through the sewer pipes connected to each house. This system avoids the use of subsidiary manholes and obviates the objections to the use of manhole covers, which in large cities, where large numbers of corporations occupy the streets, form a large portion of the pavement at street intersections. Such a system could not be introduced at the present time in American cities without enormous loss of investment on the part of the corporations occupying the streets, as with such a joint subway it would mean practically reconstruction of the entire streets under the pavements.

The introduction of the current from electric railways has been a matter of important consideration to the lighting companies, since with poor rail construction and insufficient return feeders, part of the current returns from certain sections of the system along the lighting cable sheaths, gas and water pipes, causing serious trouble at the points where the railway current leaves the conducting devices of other corporations. In Boston, where electrolysis was rapidly destroying telephone and other cables, regular inspections were instituted to determine the difference in pressure that existed between the earth and the lead sheathing of the underground cables. Wherever this was appreciable the railway improved its bonding or made a metallic connection between the sheath and the return conductors. Another method of eliminating this trouble was to keep the sheathing insulated by using a closed conduit system with good air circulation. This, however, cannot be relied upon to any extent in large cities where manholes are occupied by all kinds of pipes and where from unavoidable moisture, insulating the sheathing is impossible.

The question of electrolysis is one which must be met by all companies operating underground systems, and joint arrangements with the telephone companies are recommended for carrying on a systematic survey of the electrolytic field in all cities, so as to prevent electrolysis, rather than to cure it after it has occurred, and thus save the renewal of investment and reduce the cost of the inspection to the minimum.

The use of jute for covering lead cables is almost universal in Europe owing to the fact that it has been the practice there to lay cables directly in the ground, whereas, in America, almost all underground work has been done with the use of conduit, and jute has been employed only to a limited extent. There are very few cable manufacturers in this country who are thoroughly acquainted with the art of applying jute to lead-covered cables, and on this account the value of jute covering has not been appreciated. Unless the jute is served with the greatest of care and in the proper manner it is entirely useless, since when it is drawn into the duct it is often exceedingly difficult to remove the cable in case of trouble. Jute is of no value as a preventative of electrolysis in a wet duct.

Another disadvantage in the use of jute cables where duct systems are used is the additional duct space which is required owing to the increased diameter of the cable, and where more than one jute cable is drawn into the same duct it is often difficult to remove either cable afterward in case trouble has developed, owing to the jute adhering to the duct walls.

The use of paper instead of rubber insulation for cable is almost universal in Europe and has become more and more prevalent in this country, and with the present relative market value of paper and rubber, paper cables have a very decided advantage over rubber cables, and experience has shown that paper cables may be relied upon to give satisfaction, provided proper care is exercised in the handling of the cable, the installation skillfully made and the lead sheathing, which is indirectly the real insulation of the cable, is preserved.

A very important detail in the construction of high-tension circuits especially is what is known as the Tailleur joint. This is a mechanical coupling which carries with it the insulation for the joint. It is especially valuable in affording speed in locating trouble, as by means of it the circuit may be opened and closed very quickly and without injury to the cable at the point of opening. Where it is necessary to make a joint in the cable the Tailleur coupling is especially valuable in obviating the necessity of cutting the cable, as is the case where wiped joints are used.

The building of manholes appears sometimes to be well-nigh impossible and it is often necessary to cut away catch-basins and remove pipes in order to complete the installation. I have seen one installation of conduit line where, as the excavation was being made, there was discovered beneath the surface the butts of a line of telegraph poles, which had been erected at some earlier date and cut down and abandoned, the street having been rebuilt over the butts of the line of poles. The company laying the conduit system was obliged to take out these old butts, which was a somewhat difficult operation, in order to complete the line of conduit.

In crossing rivers and bays it is necessary to use cables, and in these cases cable of the submarine type is used. This cable is insulated with either paper or rubber, and is lead covered, juted and asphalted and protected with either a steel band iron armor or armor consisting of strands of iron wires.

In the case of shallow rivers the river bed is dredged to a depth of about 6 ft., and a diver is sent down from a small row boat to lay the cable in the trough in the bed of the river. Where large numbers of cables are to be used to cross rivers or bays, tunnels are sometimes built. The Chicago Edison Co. constructed a tunnel across the Chicago River, the shaft of the tunnel being 60 ft. deep, and the tunnel being large enough for a man to walk comfortably through. Iron racks on either side of the tunnel support 68 submarine cables of 1,000,000 c. m. each.

While there is the greatest temptation on the part of the central station manager, on account of the less amount of investment required, to erect wherever possible overhead lines, it is very questionable whether this is the wisest and most conservative policy to follow. The use of underground construction should be most strongly recommended wherever the return on the investment will permit. The experience of time has shown that in large cities the wires, at least in the business district, must eventually be put underground, and those companies that originally started with an underground system have proven the wisdom of their course.

There are many distinctive advantages to be gained in the use of underground system, such as the great freedom from danger to apparatus from lightning and the uninterrupted service in heavy snow and wind storms, and the reduction of the danger to the lives of employees and public, together with the stability of the investment and the freedom from objection on the part of property-owners and municipal authorities. All of these advantages are most worthy of consideration and should weigh heavily as against the apparent saving to be effected in the first investment cost of the lighting company.

ENGINEERING FEATURES IN THE ALEXIAN BROTHERS HOSPITAL, CHICAGO.

One of the latest hospital buildings of Chicago is the new Alexian Brothers Hospital, under the management of the religious order of that name, which has conducted a hospital in Chicago since 1869. The new hospital is at the corner of Racine and Belden Aves., on the North Side, the grounds being 596 × 269 ft., and the building itself being 307 × 236 ft.; but only 35% of the total area is covered by the building, leaving ample room for grass plots, etc. The site has only been used for agricultural purposes and pasturage, and the shallow loam is underlaid by clean sand and gravel, which had never been disturbed until the foundations of the hospital were built.

The structure has four stories and an attic, and is of fireproof construction, the exterior being of red pressed brick, with blue Bedford stone base course and trimmings, and a metal roof. It has concrete foundations, brick walls, steel floors and roof beams, and hollow tile floor arches. There are six flights of iron stairs, with marble treads and risers, the stairways being enclosed by brick walls. There is an elevator of 2,500 lbs. capacity, running at 150 ft. per minute, and operated by an electric motor in the attic. This was built by the Crane Elevator Co., of Chicago. In the towers are two steel tanks having an aggregate capacity of 10,000 gallons of water for general and fire purposes, and these are supplied with water from the city mains by means of pumps. Distributed on each floor and in the attic are 28 coils of fire hose, each 100 ft. long. In the attic are the motors, fans, and ducts for ventilation, the elevator motor, and the water and heating pipes. It has a cement floor, and is partitioned off by brick walls with metal fire doors. The furring of all walls and partitions is of Mackolite fireproof tiling (Eng. News, May 26, 1898). In the interior finish, the woodwork is reduced to a minimum, no moldings being used, and all doors having a smooth veneered surface, with no moldings or panels for the lodgment of dust.

A special feature in the design of the building is that there is no basement. The main floor is slightly above the ground level. The boiler room is set below this level (but with only a gallery along it at the level of the main floor). Thus, with the exception of the vegetable storage cellars, there is no covered apartment below the ground level. This arrangement was adopted for sanitary reasons, the opportunities for the collection of dirt, damp and rubbish in dark cellars being thus practically eliminated. Another special feature introduced for sanitary reasons was that of rounding off all corners between the floors and walls, so that there is no opportunity for the collection of dust and damp. This may be seen at the left in Fig. 1. All vertical and ceiling angles of plaster are also rounded.

On the first floor are the offices, reception rooms, emergency dressing rooms, dispensary, laboratories, special bath rooms, laundry, engine and boiler rooms, kitchen and dining rooms. Also lecture rooms, inquest rooms and a mortuary chapel. On the upper floors are five large wards for ten beds each, six for three beds each, and 25 private rooms. The total number of beds is 260, which can be increased in cases of emergency. Besides these, there are 60 rooms for the use of the "brothers" of the order. A future addition, forming the west side of the square, will contain 55 private rooms, for the use of patients suffering from nervous troubles. The operating department is on the second floor, with an operating room two stories high, finished in white vitrified tile, marble, cement and white enameled wood. The chapel, in the center of the building, is on the second floor, 40 × 90 ft., with galleries for the use of the patients on the third and fourth floors. Each floor has a pantry (with dumbwaiter to the kitchen), baths, library, smoking and reception rooms, dressing rooms, etc.

The ventilation is by means of exhaust fans, which draw the air from the wards, etc., through metal ducts, and discharge it above the roof. In the wards, there is an opening behind each bed, the sizes of the openings and ducts being so proportioned that the air cannot pass from one room to another. All openings in the wards, closets, laundry, etc., are fitted with registers. The supply of fresh air is admitted by windows and special openings, the amount being regulated as required, and in various places the fresh air is passed over heating coils. The various fans are driven by belting from four electric motors, which aggregate 36 HP. These and all the other motors were furnished by the Holtzer-Cabot Mfg. Co., of Boston, Mass.

The heating is on the Webster system, using exhaust steam, with a vacuum pump on the return end. There is usually atmospheric pressure or ½-in. vacuum on the steam main, and 12 ins. of vacuum on the return main. Live steam at atmospheric pressure can be admitted to the steam main, but this is rarely necessary. As there is no basement, the return pipes are carried under the ceiling of the first floor, and all the return from the radiators on that floor has to be lifted about 12 ft. to these pipes. There are two vacuum pumps, and the return water is pumped to a Webster feed-water heater. In the wards, etc., the temperature is regulated by the throttle on the steam pipe to each radiator. When the radiator is full of steam, the thermostatic valve partly closes, allowing water to flow out, while the steam passes directly to the next radiator. All the heating plant was put in by the Warren Webster Co., of Camden, N. J.

The electric light is used, with wiring for 1,000 lamps of 16 c. p. The wiring is in iron conduits.

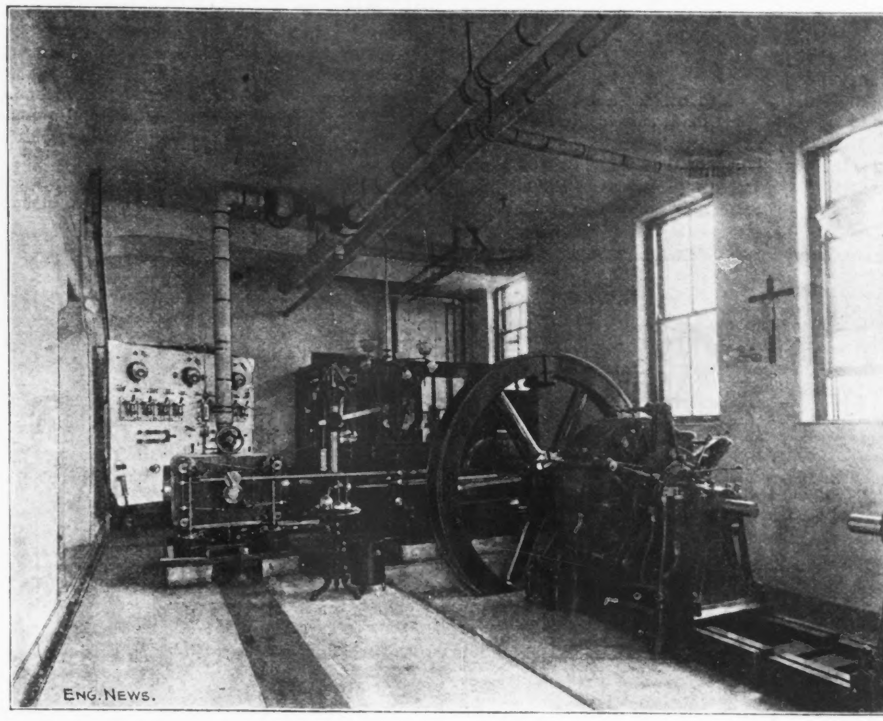

FIG. 1.—ENGINE-ROOM OF THE ALEXIAN BROTHERS HOSPITAL; CHICAGO, ILL.

In the private rooms, the lamps and call-bells are operated by push-switches on long flexible cords, so that the patients can readily call the attendants and turn the lights on or off. The fixtures are of the combination type, for gas and electric light, and for the gas supply there is a large meter of special make, with a capacity of 250 lights. For communication throughout the building there are electric bells, speaking tubes, and 18 telephones. All the latter center at the main office, but are not interconnected, so that all messages except those for the office have to be repeated. This is said to be to prevent their use for conversation.

The refrigerating plant for the cold storage rooms, the refrigerators in the ward pantries, the body case in the morgue, etc., consists of a Linde machine, having a daily capacity of 13 tons of ice. This machine was built by the F. W. Wolf Co., of Chicago, and is driven by a belt from a 20-HP. electric motor. There is also a tank machine supplying 2,000 lbs. of ice per day for the wards and tables. This is operated by a brine pump driven by an electric motor of 1½ HP.

All the water for drinking purposes and the operating rooms is first filtered in a Jewell filter plant, and then passed through a sterilizing apparatus, which is so arranged that no water can pass into the supply pipes at a lower temperature than 240° F. This water is supplied, hot and cold, throughout the building. For the cold water supply, the water is led to a cooling tank in the refrigerating room, where its temperature is lowered to 38° F., by means of an ammonia coil. Beyond this tank the water is delivered to 24 fountains, and is kept in circulation by a pump driven by an electric motor of 1½ HP.

The drainage is on the Durham system, with wrought iron pipe having screw joints. All plumbing pipes are exposed and accessible, and are of polished brass or of wrought iron painted with aluminum bronze. The bath tubs, slop sinks, urinals, drinking fountains, etc., are of solid porcelain ware, with no wooden legs or fittings.

The power plant consists of two 75-HP. Corliss engines, built by the Filer & Stowell Co., of Milwaukee, Wis. They work under an initial steam pressure of 80 lbs., cutting off at one-fifth of the stroke, and run at about 90 revolutions per minute. Each engine has a flywheel 9 ft. 6 ins. diameter. The governors are of the inverted type, with balls on top of the rods, and are said to be very sensitive. They are driven by bevel gear. The valve gear is fitted with a hand starting device. A small vertical inverted engine drives the laundry plant. Steam is supplied by two 150-HP. water-tube boilers, built by the Abendroth & Root Mfg. Co., of New York, N. Y., the working pressure being 90 lbs. per sq. in. They are fitted with the Hoppes feed water purifiers. Oil fuel is used, sprayed by steam jets from the burners. The oil is stored in underground tanks outside the building, and passed through a separator which removes the dirt. The plant is run night and day, and sometimes a boiler will run for two or three days without requiring any change of the oil-feed valve on the burner. The rocking grates are so arranged, however, that in 15 minutes a boiler can be changed to burn coal, a supply of which is kept on hand in case of emergency. The boilers also supply two hot-water tanks, one for the laundry and kitchen, and one for the baths. The boiler room is well lighted and ventilated, for though its floor is below the ground level (as already noted) it is open to the level of the second floor.

Each engine is directly connected to a 55-K-W. 120-volt multipolar dynamo, built by the Siemens & Halske Electric Co., of Chicago. These dynamos are compound-wound, with external commutators, and have a guaranteed efficiency of 93%. The armature and commutator can be moved back on the bed plate, leaving the field coils exposed for inspection and repair. The switchboard has a double bus-bar system, so that under heavy loads one engine and dynamo can supply current to the lighting circuits, and the other to the power circuits. The two systems are connected by a 600-ampere switch, so that all the load can be carried by one or both engines, as required. Ordinarily, only engine and dynamo and one boiler are in use, the others forming a reserve.

Fig. 1 is a view of the engine room. Figs. 2 and 3 show the Filer & Stowell Co.'s form of ball-and-socket floor stands for the dynamos. The stand shown in Fig. 2 is between the engine flywheel and the dynamo, and has the support for the field magnet. The one shown in Fig. 3 is at the outer end of the shaft, and has the support for the brush holder. Both have ring-oiled bearings.

Between the engine room and boiler room is a room containing the Worthington pumps, Webster feed water heater, oil tanks, etc.

All the courts are paved with cement, and well drained. Separate from the hospital building are the stable and wagon shed, tool house, carpenter shop, and a brick poultry house with cement floor.

Bro. Aloysius is President of the Board of Trustees of the Hospital, and Bro. Marius is Chief Engineer of the power plant. Mr. Richard E. Schmidt, of Chicago, was the architect of the building, and Mr. John Irwin the Consulting Engineer.

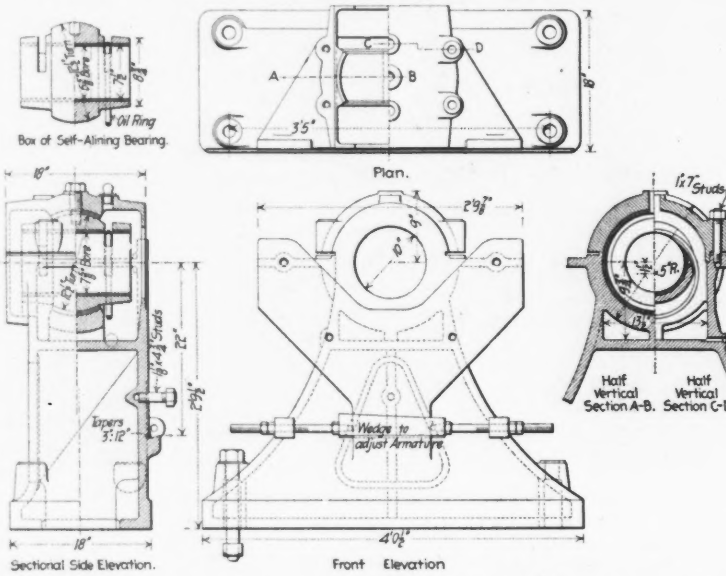

FIG. 2.—BALL-AND-SOCKET FLOOR STAND FOR DYNAMOS AT THE ALEXIAN BROTHERS HOSPITAL; CHICAGO.
The Filer & Stowell Co., Makers.

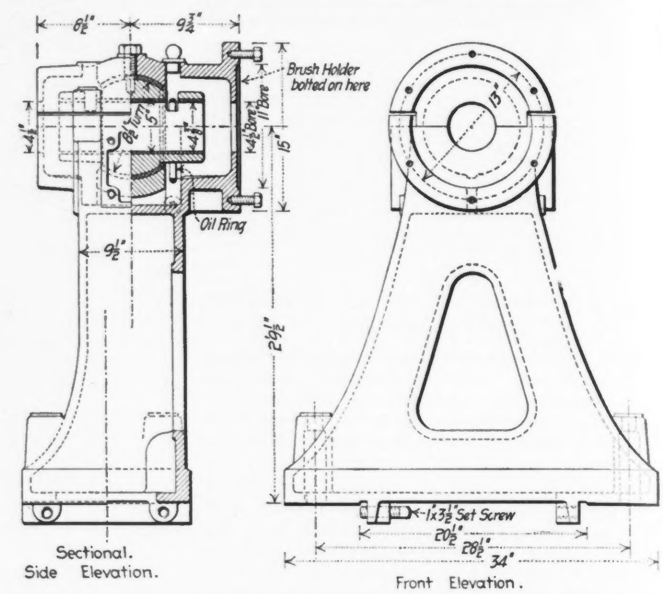

FIG. 3.—BALL-AND-SOCKET FLOOR STAND, WITH SUPPORT FOR BRUSH HOLDER.
The Filer & Stowell Co., Makers.

STATISTICS OF RAILWAYS IN THE UNITED STATES FOR THE YEAR ENDING JUNE 30, 1898.

The statistician of the Interstate Commerce Commission, Prof. Henry C. Adams, has furnished to the press an advanced abstract of the forthcoming eleventh annual report of the Commission, and from it we take the following figures of principal interest to our readers:

Mileage.—On June 30, 1898, the total railway mileage of the United States was 186,396 miles, an increase during the year of 1,967 miles. The aggregate length of railway mileage, including all tracks, on the date given was 247,532 miles, distributed as follows: Single track, 186,936 miles; second track, 11,293 miles; third track, 1,009 miles; fourth track, 793 miles; yard track and sidings, 48,039 miles.

Equipment.—On June 30, 1898, there were 36,234 locomotives in the service of the railways. This number is larger by 248 than the previous year. Of the total number of locomotives reported, 9,956 are passenger locomotives, 20,627 freight locomotives, and 5,234 switching locomotives, a small number being unclassified. The total number of cars of all classes reported was 1,326,174, or an increase of 28,694 as compared with June 30, 1897. Of the total number, 33,595 were assigned to the passenger service and 1,248,826 to the freight service, 43,753 being assigned to the service of the railways themselves. During the year, the railways in the United States used 20 locomotives and 718 cars per 100 miles of line. Referring to the country at large, it appears that 50,328 passengers were carried, and 1,343,906 passenger-miles were accomplished per passenger locomotive, and 42,614 tons of freight were carried, and 5,530,498 ton-miles accomplished per freight locomotive. All of these items show an increase as compared with those of the previous year.

Including both locomotives and cars, the total equipment of railways on June 30, 1898, was 1,362,408. Of this number 641,262 were fitted with train brakes, the increase being 115,976, and 909,574 were fitted with automatic couplers, the increase being 230,849. The summaries indicate that practically all of the locomotives and cars assigned to the passenger service are fitted with train brakes and that out of a total of 9,956 locomotives assigned to this service 5,105 are fitted with automatic couplers, and 32,697 cars out of a total of 33,595 cars in the same service are also so fitted.

Out of a total of 20,627 locomotives assigned to the freight service 19,414 are fitted with train brakes and 6,229 with automatic couplers, but out of a total of 1,248,826 cars assigned to the freight service only 567,409 are fitted with train brakes and 851,533 with automatic couplers. The number of switching locomotives fitted with train brakes was 3,877, and the number fitted with automatic couplers was 1,199. Of the total number of cars of all classes in service on June 30, 1898, 607,786 were fitted with train brakes, the increase during the year being 115,227, and 896,813 were fitted with automatic couplers, the increase being 227,876.

Employees.—The number of persons employed by the railways of the United States, as reported on June 30, 1898, was 874,558, or 474 employees per 100 miles of line. As compared with the number of employees for the previous year, there was an increase of 51,082. The amount of compensation paid to employees represents 60.52% of the total operating expenses of railways and 39.69% of their gross earnings, or $2,681 per mile of line.

Capitalization and Valuation.—The amount of railway capital outstanding on June 30, 1898, not including current liabilities in the term, was $10,818,554,031. This represents a capital of $60,343 per mile of line. The amount of capital in the form of stocks was $5,388,268,321, and the amount in the form of funded debt was $5,430,285,710. The amount of capital stock paying no dividends was 66.26% of the total amount outstanding, and the amount of funded debt, excluding equipment trust obligations, which paid no interest, was $852,402,622.

Of the stock paying dividends, 6.63% of the total amount outstanding paid from 1 to 4%; 7.15% paid from 4 to 5%; 7.60% paid from 5 to 6%; 3.69% paid from 6 to 7%; and 4.54% paid from 7 to 8%. The amount of mortgage bonds paying no interest was $526,124,188, or 11.34% of miscellaneous obligations, $146,116,874, or 30.01%; of income bonds,, $180,161,560, or 68.71%. The amount of current liabilities outstanding at the close of the year named was $540,013,995, or $3,012 per mile of line.

Public Service.—The number of passengers carried during the year was 501,066,681, an increase, as compared with 1897, of 11,621,483. The number of passengers carried one mile was 13,379,930,004, an increase of 1,122,990,357 as compared with 1897. The number of passengers carried one mile per mile of line was 72,462, as compared with 66,874 for 1897. The number of tons of freight carried during the year was 879,006,307, an increase of 137,300,361. The number of tons of freight carried one mile was 114,077,576,305, which, compared with the previous year, shows the large increase of 18,938,554,080. The number of tons of freight carried one mile per mile of line was 617,810, which is 98,731 greater than the corresponding item for the year preceding.

Earnings and Expenses.—The gross earnings of the railways of the United States, covering an operated mileage of 184,648 miles, were $1,247,325,621 for the year, being greater by $125,235,848 than the corresponding item for the fiscal year preceding. The operating expenses during the same period were $817,973,276, being an increase of $65,448,512 as compared with the year 1897. The items comprised in gross earnings were: Passenger revenue $266,970,490, mail $34,608,352, express $25,908,075; other earnings from passenger service $7,224,000; freight revenue $876,727,719; other earnings from freight service $4,683,205; other earnings from operation, including a few unclassified items, $31,203,780.

The operating expenses for the year were assigned as follows: Maintenance of way and structures, $173,314,958; maintenance of equipment, $142,624,862; conducting transportation, $464,674,276; general expenses, $36,476,686. The gross earnings averaged $6,755 per mile of line, and operating expenses $4,430 per mile of line. These amounts are, respectively, $633 and $324 greater than the corresponding figures for 1897.

Accidents.—The total number of casualties to persons on account of railway accidents during the year ending June 30, 1898, was 47,741. The aggregate number of persons killed during the year was 6,859, and the number injured was 40,882. Of railway employees, 1,958 were killed and 31,761 were injured. These casualties were divided as follows: Trainmen, 1,141 killed, 15,645 injured; switchmen, flagmen, and watchmen, 242 killed, 2,677 injured; other employees, 575 killed, 13,439 injured. The casualties to employees resulting from coupling and uncoupling cars were, killed, 279; injured, 6,988. The corresponding figures for the preceding year were, killed, 214; injured, 6,283.

The number of passengers killed during the year was 221 and the number injured was 2,945. Corresponding figures for the previous year were 222 killed and 2,795 injured. The summaries containing the ratio of casualties show that 1 out of every 447 employees was killed and 1 out of every 28 employees was injured. One passenger was killed for every 2,267,270 carried and 1 injured for every 170,141 carried. Ratio based upon the number of miles traveled show that 60,542,670 passenger-miles were accomplished for each passenger killed and 4,543,270 passenger-miles accomplished for each passenger injured.

NOTES FROM RECENT WATER-WORKS REPORTS.

The report of the Metropolitan Water Board for 1898 contains interesting illustrated descriptions of the work in progress during the year, especially on the construction of the immense dikes for the big dam at Clinton. Some account of this dike work was given in Engineering News for Oct. 13, 1898. Mr. F. P. Stearns, M. Am. Soc. C. E., is Chief Engineer.

Cement-lined wrought-iron service pipes are highly spoken of by Mr. F. F. Forbes, Superintendent at Brookline, Mass. Speaking from an experience of 25 years, he states that "not a single case of diminution in flow of water caused by the formation of rust has occurred in any of these cement-lined pipes." He also says that several of these pipes, dug up in connection with street or sewer work, have been found to have as smooth and perfect interiors as when first laid. In this connection the note given below regarding Taunton is of interest.

A remarkable record for the collection of water bills is given in the report of Mr. W. H. Harding, Registrar at Cambridge, Mass. He states that of $306,000 of water rates assessed for the year only $963 remained unpaid at its close, and about $700 of this was due from a company in the hands of a receiver. How such results were achieved is not stated. The wonder increases when it is known that besides metered services, the consumers for the year included 19,892 families, 892 stables, 821 stores and offices, and 334 shops.

Notwithstanding the low consumption of water at Fall River in 1898, only 32 gallons per capita, 27.3% of the total pumpage was unaccounted for, or 318,751,000 gallons out of 1,144,658,000. The amount consumed by purchasers was 58.47% of the total, and that used for public purposes was 14.23%. Of the 666,276,000 gallons sold, only 43,166,000 gallons were not metered; the balance includes an allowance of nearly 30,000,000 for under-registration of meters, being 5% of the actual registration. Of course, no revenue was derived from this water. The 160,000,000 gallons used for public purposes was divided as follows: Public watering troughs, 59,700,000; public buildings, 42,800,000, nearly half of which was for schools; street sprinkling, 22,400,000; sewer flushing, 11,800,000; water main flushing, 8,400,000 (estimated); extinguishing fires, 5,100,000. The only item entered in the report as estimated is that for flushing water mains. The water sold at fixture rates must have been estimated, also, and probably some of that supplied for public purposes, although meters were used to determine much of the latter. Probably the insertion of the word "estimated" in one place, only, indicates that the corresponding figure was somewhat of a guess. Mr. Patrick Kieran is Superintendent.

As one means of judging the character of its water supply the city of Lynn, Mass., has adopted a blank form to be filled in for each case of typhoid fever, as soon as possible after it is reported. Besides the residence and place of business of the patient, and facts bearing upon the cause of the disease, there are a number of questions designed to indicate the possibility of infection while out of the city, including one as to whether the patient rides a bicycle. The inquiry also covers the water, ice and milk supplies of the patient, and the condition of the plumbing of the house in which he is ill. Mr. Wm. B Littlefield is President of the Water Board, and Mr. John C. Haskell is Superintendent.

Unlike Mr. Forbes, of Brookline, Mr. Geo. F. Chace, Superintendent at Taunton, is not fully satisfied with cement-lined service pipes. He states in his last report, after reviewing the trouble with poor services during some 10 or 12 years, that:

> The argument still appears to hold good in favor of obtaining something better than cement-lined service pipes, and experience justifies the use of tin-lined pipes for services.

During the year Mr. Chace dug up one service pipe and cleaned 77 with wire. The case against cement-lined pipes does not seem so bad when it is known that the defective services for the year were less than 2% of the total, and that of the 77 cases, 23 had been in use 20 years or more; 31 for 15 years or more; 51 for 10 years or more; and 9 less than five years; while all but one service were cleaned in place.

The first annual report of the water department of Watertown, Mass., contains an interesting account of the purchase of the works from a private company, including a report on the character and value of the plant by Mr. Percy M. Blake, of Hyde Park. Mr. B. F. Davenport is Chairman of the Committee on Water Supply.

The last report of water commissioners of Albany, N. Y., contains a large number of views of the new filter plant, for which Mr. Allen Hazen, Assoc. Am. Soc. C. E., in Engineer. Mr. Geo. I. Bailey is Superintendent of the works.

The use of the Deacon meter as a means of locating water waste was continued with good results at Washington, D. C., during the year covered by the last report of Mr. W. A. McFarland, Superintendent of the Water Department. The work was under the direct charge of Mr. John Green, who states that after locating houses in which waste was found, having the plumbing put in order and faucets kept closed, the meter registered only 35 to 50% of what it did previously; in other words, 50 to 85% of the water passing through the mains in each section tested was running to waste. In using the meter a section is selected where the distributing mains permit of sending the whole supply past one point. First a record of consumption for the full 24 hours is secured, the registration betwen 12 p. m. and 5 a. m. being taken, in strictly residence districts, as all waste. Next a record is taken from 12 p. m. to 5 a. m., the inspectors meanwhile shutting off one valve after another, at intervals of a few minutes, then reopening them, noting the exact time each valve is closed and opened. By comparing the time of closing and opening valves with the meter chart, the streets on which the most waste is occurring are indicated. The next step is to shut off house by house on the suspected streets, after cutting off the water from all other streets in the section, so far as possible. The diagram thus obtained, compared with the data previously secured, and the notes of time each service was shut off and turned on, indicates the houses in which water is running to waste.

The benefits of the meter system at Richmond, Va., become more apparent as time goes on. The last report of Mr. Chas. E. Bolling, Superintendent of Water-Works, states that at the highest points of the works water now reaches an elevation 22 ft. above that attained before meters were introduced. The water power pumps are now run at a lower rate of speed than formerly, and the steam pump was not run at all in 1898. The per capita consumption is now 100 gallons, against 125 in 1895. About 25% of the revenue in 1898 was from the 3,675 metered services.

Of a total consumption of 40,877,000 gallons of water at Wyoming, O., in 1898, there was used for street sprinkling 3,562,000 gallons; sewer flushing, 529,000; fountains, 997,000; and school buildings, 227,000; making a total of 5,315,000 for these public purposes, or about 13% of the total. Mr. John W. Hill, M. Am. Soc. C. E., is one of the Trustees of the works. Wyoming is a suburb of Cincinnati.

Under a new schedule of water charges water will be sold at Milwaukee by meter measurement at a flat rate of 6 cts. per 1,000 gallons, with an additional charge of $1 a year for reading the meter. Based on the records for 1898, there will be 12,000 metered consumers in 1899, paying not over $2, and 5,900 paying not over $1 per year for water; aside from the charge of $1 for reading the meter. The previous rate for metered water was 15 cts. per 1,000 gallons. The various city departments will hereafter pay for water used by them, which they have not been doing in the past. The total consumption of water has not materially increased since 1890, although the population is much greater. This is credited to the use of meters, without which larger mains and more pumps would have been required four or five years ago. Mr. Geo. H. Benzenberg, M. Am. Soc. C. E., was City Engineer in 1898.

The use of a new reservoir at Minneapolis in 1898 was accompanied by a typhoid death rate of 30, against 100 in 1897. The bacteria in the water were reduced 25 to 50%. The typhoid death rate was lower for 1898 than for any previous year since 1878. Mr. F. W. Cappelen, M. Am. Soc. C. E., City Enginer, in his report for 1898, attributes this reduction to the use of the reservoir. While this doubtless contributed largely to that desirable end, it seems very likely that other causes were also at work.

The use of wooden joints, in place of lead, in a 24-in. cast-iron supply main at St. John, N. B., is noted in the last report of Mr. Wm. Murdoch, Engineer and Superintendent of the Department of Public Works. This practice was decided on in view of the "entire satisfaction" given by wooden joints in a 12-in. main laid in 1851, and a 24-in. main laid in 1857. The plugs are made from "clear dry pine staves, free from knots, gum and shakes." The staves are driven home and tightly wedged. The joints are tested by filling the pipe with water before covering it. Where for some reason the pipe had to be covered before it could be tested, or the joints were too open or too close to permit the use of the wooden plugs, lead joints were substituted. The staves were furnished by the A. Christie Wood Working Co., of St. John, at 13 cts. per joint for 24-in. pipe, and 7 and 6 cts., respectively, for 12 and 8-in. branches. The 24-in main will be 16,900 ft. long. The 24-in. pipe was laid by day labor at a cost of about 70 cts. per wooden joint for both labor and material, or 57 cts. for labor alone. The excavation, refilling and cartage was done by contract. Hatch boxes are being built in the line to admit scrapers for cleaning the pipe.

THE CANTON-HANKOW RAILWAY PROJECT has assumed a new character. Through a recent agreement to pool their interests made between the American-China Development Co., which holds the concession for the Canton-Hankow line, and the British & Chinese Corporation, Limited, having a contract for a railway from Canton to Kowloon. Briefly stated the agreement, as published by the daily papers, provides that: (1) Each party shall offer to the other a participation of one half of its own interest in any business hereafter obtained by it in the Empire of China a reasonable time after the same shall have been obtained, and the party to whom such participation shall have been offered shall have the option to accept or reject the same within a reasonable time, and shall be under no obligation to accept such participation. Any such offer if not accepted within a reasonable time shall be deemed to be rejected. (2) In addition to the business to be hereafter acquired by the respective parties this agreement shall apply to the preliminary contract which the Development Co. has already entered into for the construction of a railway from Hankow to Canton and to the preliminary contract which Messrs. Jardine, Matheson & Co., on behalf of the Corporation, have entered into for the construction of a railway from Canton to Kowloon.

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ADVERTISING RATES: 20 cents a line. Want notices, special rates, see page XXII. Changes in standing advertisements must be received by Monday morning; new advertisements, Tuesday morning; transient advertisements by Wednesday morning.

New York city, by increasing its tax assessments, again finds itself in a position where it can borrow money for needed improvements without exceeding the debt limit fixed by the Constitution. Under these circumstances the usual crop of schemes, good, bad and indifferent, is being brought forward and publicly agitated. The New York Rapid Transit Commission has done well in publicly calling attention, to the fact that the rapid transit enterprise is entitled to the first claim upon the treasury. Of all the various public improvements which are now under consideration it alone promises to repay directly a large interest on its cost. Besides this it will bestow indirect benefits as great or greater than those which can be claimed for any other public enterprise. The proposed Coney Island park is in many respects a meritorious scheme, but it is a work of public charity only. The Rapid Transit Railway, by making accessible cheap houses in the northern part of the city and reducing the time spent in travel, will do a vastly more beneficial work than any summer recreation ground could positively effect. Better and more roomy houses are the great need of the crowded millions on Manhattan Island, and nothing should stand in the way of plans by which they may be secured.

A possible aid in the solution of the electrolysis problem is suggested by the experience of St. John, N. B., with wooden pipe joints, in place of lead. In 1851 the city laid a 12-in., and in 1857 a 24-in., water supply main, some miles in length. Instead of running the joints with lead and calking them, pine plugs were employed. Within the past two years this practice has been repeated on another 24-in. supply main, and on some smaller branches. The object both in the fifties and now seems to have been wholly the saving of expense. The material for the work recently done is supplied by a local wood-working concern for only 13 cts. per joint for the 24-in. pipe, and the cost of labor was only 57 cts. more, making 70 cts. in all, for lowering the pipe into the trench and calking the joint. The recent work was done by Mr. Wm. Murdoch, Engineer and Superintendent of the Water and Sewer Department of St. John.

As some of our readers may remember, it has been suggested by Mr. Harold P. Brown (Eng. News, Nov. 3, 1898, p. 288), that two or more lengths of wooden pipe be placed in water mains at intervals in danger districts. If the use of wood joints in place of lead could be practiced as successfully elsewhere as reported at St. John, this practice would seem to be simpler yet. Even if some leaks should occur they would be far less serious than those that might be caused by electrolysis.

An interesting but little known bit of history in connection with early steam navigation on the ocean was brought to public attention in the recent address of the venerable Kivas Tully on his election to the Presidency of the recently organized Engineers' Club of Toronto. This was to the effect that to the Province of Quebec belongs the credit of having built the first steamship that crossed the Atlantic from either side. The steamship was called the "Royal William," commanded by Capt. McDougall, and sailed from Quebec on the 5th of August, 1833, arriving at Gravesend on Sept. 11, having steamed the whole distance.

This seems at first sight to contradict the well-known claims to priority made for the "Savannah" as the first steamship to cross the Atlantic. The "Savannah," however, on her memorable voyage from Savannah to Liverpool (May 26, 1819, to June 20, 1819) used her engines during 18 days and progressed under sail the remainder of the time, the paddle-wheels being hoisted on board when not in use. The "Royal William," therefore, appears to have been the first vessel to make the voyage using steam for the whole distance. It was not until five years after the voyage of the "Royal William," however, that regular steam navigation across the Atlantic was established by the voyages of the "Sirius" and the "Great Western."

The total casualties to those engaged in coupling and uncoupling railway cars in the fiscal year ending June 30, 1898, were 279 killed and 6,988 injured, an increase of 65 in the number killed and 705 in the number injured over the preceding year. This increase is especially noteworthy in view of the fact that the Interstate Commerce Commission in its last report expressed the belief that the good effects of the introduction of the M. C. B. coupler were already apparent in the reduction in casualties due to coupling cars which occurred in the years 1896 and 1897. By the same method of reasoning it might now be argued that the automatic coupler was proving a failure so far as the saving of lives and limbs is concerned.

It is our belief, however, that neither of these conclusions is warranted. The reduction of accidents in 1896 and 1897, so far as it was not a mere chance variation, was due only in small part to the increase in M. C. B. couplers; for, as we showed in our issue of Jan. 19, 1899, only a very small proportion of the couplings between cars were made automatically even in 1897. In 1898, however, the average number of freight cars with M. C. B. couplers was 60%; and, making reasonable allowances for the greater mileage made by the classes of cars equipped with M. C. B. couplers, it is probably a fair estimate that half the couplings were made between automatic couplers. Against this we have to offset the fact that probably 30% of the couplings were "mixed" between a link and pin drawhead and an M. C. B. coupler, and the greater danger and probably greater casualties in this process may have done much to offset the saving in lives and limbs in making automatic couplings. The greater number of employees and large increase in traffic must also be considered in comparing the accident records of 1898 and 1897.

After making all these allowances, however, we are still inclined to believe that the increase in coupling accidents reflects, in some small degree at least, some of the defective work in the equipment of cars which has been done during the past two or three years especially, some of the evidences of which were reviewed in our issue of June 22. From this point of view the increase in casualties is a matter which railway officials should seriously consider.

THE PROTECTION OF OVERHEAD BRIDGES FROM LOCOMOTIVE GASES.

Is the engineer who places a steel structure over the tracks of a steam railway and leaves the metal exposed to the attack of the sulphurous gases from the locomotives doing his duty to his clients? This question was recently raised during the visit of the American Society of Civil Engineers to the new subway of the Philadelphia & Reading Railway in Philadelphia. The depressed tracks of this subway are crossed in several places by steel bridges with solid floors, and that at Broad St. is especially notable for its width. The under side of these bridges is directly exposed to the gases from the locomotives. With the very small head room, and the heavy traffic, cleaning and painting of the iron work thus exposed will be practically impossible, and the condition of this surface after the sulphurous gases have got in their work for a few years can be easily prophesied.

We have instanced this especial structure merely because it has been so recently brought to engineers' attention, not because its engineers are any worse sinners than the generality of the profession. They have done, in fact, what it is common practice at the present day to do, and the point we wish to raise is: Should not this practice be changed?

The corrosive action of locomotive gases is now a matter familiar to every engineer; it is just as certain that these gases will rapidly corrode iron and steel surfaces as it is that sulphuric acid will do it. Is it exactly creditable, then, to the engineering profession to go on putting up expensive steel structures just where they will be most exposed to these corrosive agents, and providing them with no better protection than a coat of paint? What will be the life of structures exposed as is the Broad St. Bridge for example? Will it be 50 years? We doubt whether any engineer could be found to predict for it so long a life. Will it be 25 years or 15 years or 10 years? How much risk is involved in the reduction of the sections due to the gradual corrosion? How much does this unknown and unwatched process decrease the factor of safety from year to year?

These are some of the questions which it seems to us engineers should ask themselves in all seriousness.

The work of abolishing grade crossings of railways and highways is extending year by year. Every year sees a great number of additions to the list of overhead bridges crossing railway lines. Most of this work is carried out in the most thorough and substantial manner. The public and the corporations which are paying for the work consider and expect it to be permanent, and the engineer ought to spare no pains to insure its permanence. He is not doing this, however, we maintain, when he calmly puts all his expensive steel floor system and the bottom chords of girders or trusses into a bath of sulphuric acid and leaves them to certain and rapid destruction. Such a practice should not be dignified by the name of engineering; it is just common, ordinary folly. The engineer is supposed to have enough knowledge and intelligence to look ahead and build for the future as well as the present. This is one of the reasons why he is employed.

If, then, the engineer does look ahead into the future and sees his work rapidly dissolving into rust, so that it becomes a source of anxiety in ten or a dozen years, requires extensive repairs in fifteen years, and perhaps entire renewal in a score of years, why does he not take some steps to prevent these troubles at the outset. It surely is not creditable to the engineering of the present day that heavy steel bridges should have a life of only a quarter of a century, more or less. The old time wooden trusses which the founders of bridge engineering in this country built, lasted far longer than that.

It is possible that we might have had this matter settled on a satisfactory basis at an earlier date had it not been for the paint men. They have laid so much stress on the protection of iron work by paint during the past few years that all the attention of engineers has been turned in this direction. So many paint makers have affirmed with positive assurance that their paint was proof against the most corroding agents that engineers have taken them at their word and have put painted ironwork into places where no paint ever stood or ever will. As the paint gradually disappeared some conscientious engineers have repainted and have gone on repainting until the accumulation of coat after coat became too evidently worthless to continue the process longer. Others have resigned themselves to the inevitable and let the rusting go on without attempt at interference.

We have said that no paint can stand when subjected to locomotive gases. The exhaust from the locomotive smokestacks carries with it pieces of cinder, ash and sparks, which act like a sand blast on any surface exposed to it. No paint can endure such an exposure, and we very much doubt whether any paint will be found permanent where it is constantly exposed in a damp atmosphere to the smoke of locomotives burning sulphurous coal even apart from this sand blast action.

Supposing that such a paint were on the market, however, its manufacturer would doubtless require that it should be renewed as often as once in three years, and that the surface should be thoroughly cleaned before application of the new coat. What does such thorough cleaning and painting at three year intervals cost? How difficult is it to do it where traffic is heavy and head room is limited? Can a structure be fairly called permanent which requires such careful nursing to protect it from decay? These, again, are some of the questions which the profession will do well to consider.

We shall perhaps hear it given as a valid excuse for these exposed overhead bridges that they represent the best the engineer can do; but is this true? Is the brick or masonry arch wholly obsolete in the engineering world? Might it not even prove the cheaper structure in the long run in certain places if the life of the steel structure were set at its true figure?

Again, is there nothing better the engineer can do to protect the under side of a steel structure than to smear it over with a coat of paint, requiring frequent renewal in any event? It is no credit to American ingenuity to answer this question in the negative.

One recent solution of the problem which has been tried in St. Louis was illustrated in our issue of Jan. 26, 1899, where a wooden ceiling of 2-in. pine has been built on the under side of some bridges, completely protecting them from the action of the locomotive gases. We risk little in saying that such a protection will pay a handsome interest on its cost in the shape of reduced cost of painting and increased life of the structure. The wood itself, protected from the weather, should have a very long life, and the smoke and fumes which are so destructive to the metal work may be actually preservative of the wood.

The chance of the wooden ceiling taking fire is of course a real objection to its use. Why not, therefore, go a step further and substitute a coat of incombustible plaster laid on metal lathing for the wood? The engineer engaged in building construction builds floors every day and covers all his iron work from sight. Why may not the bridge engineer do the same? If he still clings to the old dictum that every piece of iron in a bridge must be left exposed so that it can be inspected and painted when necessary, he may use a suspended ceiling which will protect all his ironwork and still leave it accessible. As a matter of fact, however, it is precious little inspection that the ironwork on the under side of such bridges as we are considering receives. Why not then cover it once for all with a coat of good cement mortar in the original construction? To do this might require some alterations in the general design of the floor system and some special provisions in the design of the structure, but they need not be very radical. In fact, we risk little in saying that any of the drafting rooms of our large bridge works will produce a design for an overhead bridge with the under side of its floor entirely protected whenever bridge purchasers shall include the provision of some such protection in their specifications.

Even as we write a clipping comes to us with the following headlines.

LIKE ROTTEN WOOD.

PORTIONS OF THE IRONWORK OF LEONARD VIADUCT.

Have Been Made So by Corrosive Influences—Engine Smoke to Blame in This Case.

We need not take space to quote the article which follows as the facts it sets forth are perfectly familiar to engineers. We will only remark that the structure to which it refers was erected only six years ago.

This is only a sample of the reports of such corrosion which are all the time appearing and of which recent engineering literature is full. Is such a state of affairs creditable to the engineering profession? Is it not high time for a radical reform to take place in this matter? We submit the question to our readers.

LETTERS TO THE EDITOR.

The Work of the Volunteer Engineers in Porto Rico.

Sir: I was interested in the letter printed in your issue of June 22, giving information regarding the work of the First Battalion, First Regiment U. S. Vol. Engineers in Porto Rico. One good piece of work by this regiment, though probably not by the first battalion, should not be overlooked. It was the survey of Guanica Harbor, Porto Rico, made in 1898, under the direction of Lieut. Sanford L. Cluett. Mr. Cluett left the senior class of the Rensselaer Polytechnic Institute a few weeks before Commencement, 1898, to join the Volunteer Engineers. He was nevertheless graduated in the civil engineering department with his class. He kept the notes of the survey intact, and upon his return, and even after he was mustered out of service, he made a very complete and very handsome topographic and hydrographic map of Guanica and Guanica Harbor, including all titles and legends, which was photo-lithographed without charge and published by the U. S. Coast and Geodetic Survey in April, 1899. It is a satisfaction to note that Mr. Cluett was mustered out of the service as a captain.

Palmer C. Ricketts.

Rensselaer Polytechnic Institute, Troy, N. Y., July 12, 1899.

The 75th St. Sewer District, Chicago.

Sir: On page 1 of your issue of July 6 appears an item to the effect that the city of Chicago is about to drain the territory between 75th St. and 87th St., east of Ashland Ave., into the South Side Intercepting sewer, and that this will stop the pollution of the water taken in at the Hyde Park crib. This latter statement is erroneous.

It has been proposed to create a sewer district as above described, to drain into the proposed extension of the intercepting sewer, as all this territory is within the Chicago Drainage District, and has paid its part of the drainage tax. This proposed new sewer district, however, is practically without either drainage or sewers. There are a few small pipe sewers at the extreme western end, but these empty into the Halsted St. main, which discharges into the Stock Yards slip.

There is not a sewer north of 87th St. emptying into the Calumet River, or in any way polluting the water taken in at the Hyde Park crib, nor has any plan been adopted looking to the solution of the problem of preventing the pollution of this part of the water supply, although the pollution is estimated to be equivalent to that from a town of 900,000 population. People residing between 87th St. and 39th St., numbering about 400,000, while paying their tax for the construction of the Main Drainage Canal, will receive but a doubtful return for their money when this canal is opened, for the reason that no plan is being put into execution to purify their water supply, although the purification of the water supply of Chicago is the usual (if not the legal) excuse for the expenditure of some $40,000,000. The Calumet River must be diverted at a cost of millions of dollars before the water taken in at the Hyde Park crib (and supplying these people) is unpolluted by sewage.

F. E. Davidson, M. W. Soc. E.,
Ex-Superintendent of Sewers.

Chicago, Ill., July 10, 1899.

(In the item referred to by Mr. Davidson the 75th St. district was evidently confused with the 95th St. district, which was shown on the map accompanying the article on the intercepting sewer system in our issue of April 21, 1898. The trouble from the Calumet River is not so much its pollution by sewage proper as its pollution by waste and refuse from the factories and industrial establishments along its banks. The most satisfactory plan of preventing the pollution from extending to the lake and the intake crib (supposing that the factories are not restrained from turning their filth into the river) appears to be that of building a channel from the river westward to a junction with the drainage canal, so that the flow will be westward to the main drainage canal instead of eastward into the lake. This plan, as well as that of providing sewerage for the 95th St. district, was described in our issue of Aug. 25, 1898.—Ed.)

Random Notes Abroad.

IV.

Sir: From San Remo to Genoa the railway line is mostly in tunnel, and the journey of several hours is very wearisome, the monotony of the tunnels being broken only by glimpses of the Mediterranean. Genoa is still a thriving seaport; its harbor is crowded with shipping and its docks and wharves with merchandise. The streets are paved with stone blocks about 2 ft. long, 1 ft. broad and 8 ins. deep; the roadbed was carefully graded, and the covering was fitted with even surfaces and close joints. The streets are frequently so narrow that no raised sidewalk is laid, the pavement being carried to the walls of the houses, with the "crowning" concave instead of convex, to carry the storm water along the middle instead of sides of streets. This plan is followed in the usually narrow streets of all Italian cities. In Florence the paving blocks were large, as described above, and were laid with cement joints; work is done in the most leisurely manner, and street openings are not contemplated.

In fact, in Florence, many streets are paved with stones of most irregular shape, laid in cement. To break up the surface for laying sewers or water pipe would break up a most intricate puzzle in stone blocks, not easily replaced. In Rome, unlike other Italian cities, the paving blocks are only about 4 ins. square by 6 ins. deep—they are mosaics—and a large proportion of the streets are without raised sidewalks; pedestrians use the whole width of the street; even on the Corso—the Broadway of Rome—the sidewalks are but about 3 ft. wide, increasing, however, up to 12 ft., where the street has been widened. In Rome the only evidences of a street department are men at frequent intervals with a cart containing a hand watering can, brooms and dust scoops; the streets are being swept constantly by hand-brooms made of withes. The accumulation is carefully stored to be carted to the adjoining farms. There is no sign of street openings, however, and no appearance of civil engineering work anywhere; omnibuses with bodies like street cars are hauled over the pavement, through the very narrow winding streets in all directions, up and down the severe hills by the most emaciated horses I ever saw. There are excellent electric tramways also, with a uniform fare, and for other transportation there are innumerable cabs at a very cheap rate.

However much one may read about the ruins of ancient Rome, an intelligent idea of the situation can be gained only by a visit and personal study. It was always a mystery to me how a city of two millions of such energetic people as the Romans of Julius Cæsar's time were could be completely buried in rubbish so that the location of its great palaces and monuments were quite lost. But when one comes, in the center of the modern city, upon Trajan's Column, standing intact in the Forum, and learns that the top of this 30-ft. column marks the level of the rubbish heap on which a cattle market was maintained for centuries, and when we also realize that for a full thousand years the ruins of ancient Rome have been used simply as a quarry for the building and decorating of modern or medieval churches in many Italian cities, for public buildings, for the villas and enclosing estate walls of nobles, for limekilns, for street paving and other purposes, then it is quite understandable how the rubbish piles would eventually blot out all vestiges of former grandeur.

This idea of "bigness" has prevailed from the earliest Roman history to the present time; the Italian government—the poorest financially in Europe—has planned on a scale which even the richest of other nations do not emulate. Its new treasury building covers more space than either St. Peter's or the Colosseum; the new Victor Immanuel statue, when it is completed and the buildings are cleared away for the approach from the Corso, will have no equal in splendor and costliness in Europe. Other vast structures in Rome uncompleted and barely in progress attest this straining after the colossal, without regard to the hardships it imposes on the tax-burdened people. It is the old story of Nero's golden house, or the vast theatre of the Colosseum that now occupies part of its former site.

Leaving Rome by the noon express, the tourist journeys through the Campagna, and not far from the famous Appian Way, the great Roman road of ancient times. The grade leads up into the Alban hills. Slowly the train climbs the rising grade until the summit in tunnel is reached, when the line descends to the plain, which becomes ever more flat as it approaches the sea near to Naples.

The average tourist goes to Naples to "do" the Museum, Pompeii, Vesuvius, and probably Sorrentum, and Capri with its blue grotto. By the time this is accomplished he is ready to free himself from the sharp hotel man, the banditti of cabmen and the omnipresent beggar. When he had passed over his final tip to the railway porter and his compartment door is locked by the "guard" for the night journey to Rome, he feels a genuine satisfaction—at least this was my own state of mind.

From printed pictures, "peep-shows," panoramas and photographs, the untraveled portion of the world have been made familiar with the resurrected city of Pompeii. There are features, however, which cannot be shown pictorially. One must visit Pompeii itself to realize the street system; its narrowness, limited usually to the width of the wheeled vehicle of the times, and such streets being limited to only a half dozen or so, as proved by the condition of the pavement. The "sidewalks" are raised usually a foot or more above the street pavement and are never more than three or four feet wide, and oftener less. Two stepping stones even with the level of the sidewalk allow for crossings. On the wagon roads these were spaced for the animals and wheels to pass between; the pavement, as in ancient Rome, was what we would now call "accentuated cobble," so large and broad and uneven were the paving stones, into which wagon ruts, 6 to 10 ins. deep, with many deeper holes, are worn; evidently, in these far away times, a street or road once paved was considered finished for all time. Certainly carriage driving in Pompeii, or indeed on any Roman road, could not have been in much favor with the ease-loving members of either sex. As it is to-day in the old parts of Italian cities, the streets were narrow, unlighted lanes between the solid rows of houses on either side.

Immorality and vice ran riot in Pompeii. If ever a community deserved the fate of Sodom it was this ancient city. Cut on the pavement and on the cross stone beam over the doors were the "signs" of houses of ill fame. In all houses of the wealthy people which have been uncovered (and the most recent are in excellent preservation) the walls were frescoed with pictures of the nude, without any pretence of modification, for the daily study of the whole household. There must have been artists who painted and sculptured mostly, if not entirely, in the works of bestiality, as the large—"for men only"—roomful of relics in the Naples Museum amply attests. The guides over the excavations signal the men—when with ladies—quite too often to "keep an eye out" for the unusual in "signs." The combination of Naples, Vesuvius and Pompeii fetches one as near to "sheol" probably as can be reached on the surface of our planet.

A volcano cannot fail to interest every human being who has the least spark of curiosity in him; so in approaching Naples the first sight of the column of smoke and steam issuing from Vesuvius marks a moment in one's life never after to be forgotten. Every other association of this fascinating region pales before that of the historic mountain, so often the cause of terror and of actual disaster to the communities clustered around its base. Years ago a visit to the cone of the volcano was a most fatiguing journey, not to be attempted except by the physically strong. It is a fatiguing trip now, but civil engineering has made it a comparatively easy one, and even a physically infirm person may now take a peep into the awful abyss. Our party of four—two being ladies—engaged the day previous, from Thos. Cook & Son, a double team and carriage to start from our hotel at 9 a. m.; the carriage was not at hand at 9.15 a. m. so we had to go to Cook's office to find that the engagement had been quite forgotten, although we had paid for the full service in advance. We were then obliged to accept the best that could be got, and finally got away a half hour late. Near the limits of the city we halted while an additional horse was "hitched on" with an attendant boy on the driver's seat; and such a horse! We protested against such a skeleton being added to our "scarecrow" pair; but the driver did not know one word of English and as our combined stock of Italian and French was too meager for the occasion, we simply submitted to the pleasant grimaces of the Jehu, who probably thought we were only amused by the situation instead of being quite alarmed as to the possibility of being conveyed over the "long haul" up the mountain side by the sorry beasts who had us in tow. But, strange to say, those three horses, although apparently only fit for the boneyard, not only dragged us up, but actually passed the procession of two and four-horse brakes, already despatched by Cook's people. As most Neapolitan horses used on public vehicles are animated skeletons, we were soon reconciled to the lack of style in our outfit.

Before the first lava bed was reached we discovered that two sturdy young fellows, one with a nail-pointed staff in hand, were quietly keeping abreast of us, and as the lava was reached, one of them explained in excellent English its date of flow, told about the near vicinity, pointed out any remarkable house or scene of any volcanic event and occasionally assisted in blocking the carriage wheels when our weak-kneed Rosinantes halted for a breathing spell. After a couple of hours' pull we were amid the bare lava fields. Everywhere was the awful, solidified current, in the undescribable shapes of a deep flow of slag down a hill side, or of a vast mass of treacle, just fluid enough to move. The various eruptions were distinguished by the freshness of the mass.

At places the carriage road had been obliterated by the lava and a new route cut around joining the old road further up. The road itself is an excellent piece of engineering, amid the most difficult and dismal surroundings. The demoniacal desolation of a lava field of recent date must be seen to be realized; the bleak bowlders of Mt. Washington or of Pike's Peak are quite bland in comparison, because amid the lava beds one progresses amidst the apparently agonized contortions and shapes of a recently moving viscous mass, while on the other mountains the vast slopes of broken granite have an appearance of regularity and repose. When within a mile or so of the end of the carriage road our companion with the pointed stick came to the front while we were halted, and his "pal" explained that if we would hand over some pennies the man with the stick would take a short cut to the liquid beds of flowing lava, imbed the pennies therein, and meet us farther up the mountain with our pennies in the still hot lava, all for the small sum of one franc per penny imbedded. A memento of this sort is worth having, and the men also had been very useful and polite; we forked over a couple of pennies, not caring to deplete the stock of lava further, and in due time received back our mementos at the stipulated price. Afterwards, on the cone, every Italian guide and assistant had similar mementoes for sale at "reduced prices by the quantity" of two or more.

At last our sorry beasts and those of the other parties have hauled their loads to the end of the Cook's road, passed the Cook's gateway and the observatory, and are safely landed in the yard of the Funicular Railway station, the line and appurtenances being the personal property of Mr. John Cook, son of the great tourist manager. Our ticket takes us to the top of the "Funiculare"; we are soon on the way up, a party of twelve being the maximum load allowed. The car runs on one rail, and is supported on each side of the great wooden longitudinal beam by side rollers; it seems at first a little wobbly, but that soon wears off, and, as on other steep mountain rack railways, one resigns himself to the chances—with the reflection that it is highly improbable that any catastrophe would occur on this particular trip. The time of ascent was eleven minutes, the angle about 65° from the horizontal. There were no exuberant remarks and everybody was evidently glad when the upper station was reached and we were off the car.

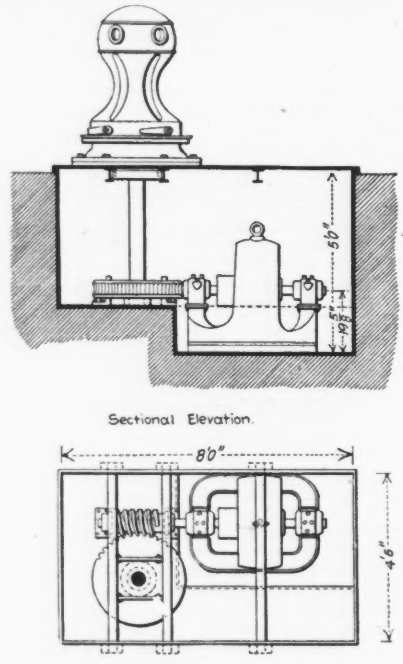


Fig. 7.—Electric Capstan, Boston Dry Dock.

Motor 22.5 K-W., 30 HP., 575 R. P. M.
Cast-Iron Casing for Pit, 1-in. thick.
Flanged and Bolted.
Worm, Cast Steel.
I-Bars, 4-in. Steel.
Cover Plates, ½-in. Steel.

We were now in a thick fog; everything was black and damp; we stepped out of the station house into deep, black ashes and also into a group of dark-faced, villainous-looking Italians. The jurisdiction of John Cook stops at the exit of this railway station; the Italian government then appropriates you; a fee of two lire each for a party of 12 is paid over for the guide; for two lire more you can grab hold of the end of a stout rope and be towed up through the deep, yielding ashes to the edge of the crater, and for 10 lire ($2) a chair on poles and two men to carry you up are furnished. I walked up unaided, as nearly everybody else did, to the disgust of the "towers." The ascent of the cone commenced with a climb of steep lava steps covered with ashes, at the top of which we emerged from the cloud into the most beautiful sunlight and onto a long, easy slope of probably 1,000 ft., terminating at the edge of the crater. The distant view of the Appenine peaks showing just above the sea of clouds was lovely beyond description; otherwise the world below and around us was hidden by the black veil of cloud at our feet.

We were allowed to go to the very edge of the crater, but were allowed to remain but a few moments in one place and not many in a group. Imagine a vast inverted cone-shaped abyss, the bottom entirely hidden from sight by ashes and steam, and darkened still further about every two minutes by still darker masses of ashes and steam accompanied by noxious fumes, after regularly recurring explosions, which one could hear plainly but not see, and which also were followed by showers of heavy bodies falling back into the liquid lake below. Then the awe-struck beholders leaning over the brink of the horrid place are driven back by the sulphurous fumes. They run down the slope a short distance, and while the ashes are showering down on them cover their faces to prevent inhaling the noxious gases and recover breath to return to the interesting point of view. The opposite side of the great bowl is quite invisible; the sides slope almost perpendicularly from the rim to the hidden depths below. In some spots the sides have worked away from under the edge; and my flesh creeps as I write to think of our standing over such an "undercut" of loose ashes for even the moment that the guide permitted. The crater is being continually enlarged by "slides"; I asked the guide how they permitted approach at all to the edge and he said that there were always previous indications of the side giving way. All the same, it is a dreadful nightmare—the thought of that horrible, bottomless hole belching up its noxious vomit of smoke and ashes, and lava stones and sulphur, from amid the darkness. It was fascinating, too, with all its danger and awfulness, and I ventured to the edge again and again at several points. If time had allowed, I would have made the entire circuit of the hidden rim. The whole slope was encrusted with sulphur and chunks were on sale at a half cent each.

We sank deep in the black ashes as we ran down the descent in long strides. The descent of the "Funicular" was accomplished without incident in eleven minutes; we omitted a visit to the liquid lava beds, about a mile distant, for which the guides charged two lire per person. We were hauled back to our hotel by 5 p. m. by our sorry team, very fatigued in body, but well pleased with our visit to a real live and active volcano. The trip is an expensive one, but it has been an expensive undertaking to construct the roads to the crater, and they are expensive to maintain, and the travel is confined to a few months of the tourist season. G. H. F.

THE NEW DRY-DOCK FOR THE U. S. NAVY AT BOSTON, MASS.

(With two-page plate.)

Under the pressure of demand for more and larger dry-docks for the ships of the "new navy," and attracted by the relative cheapness and speed of construction, the U. S. Navy Department, about 1886, adopted timber as the material of construction for its dry-docks. Between 1887 and 1897 docks of this type were built at New York, Norfolk, League Island, Port Royal and Puget Sound; and the last Congress, in spite of the able argument for stone docks presented by the present Chief of the Bureau of Yards and Docks, provided for four more timber docks. But the bill did finally make a concession to the effect that the Secretary of the Navy might, in his discretion, build one of these docks of stone; provided that the cost of this stone dock would not exceed $1,025,000, or about 25% in excess of the limiting cost of timber docks, fixed at $825,000 each. In our issue of April 6 the arguments advanced by Rear Admiral M. T. Endicott, the Chief of the Bureau of Yards and Docks, and by other well-known experts, favoring stone or concrete construction, were fully set forth, and these will not be repeated here. It is sufficient to say that the Secretary of the Navy exercised the discretion granted him in the case of the Boston dock, and on Jan. 31, 1899, he invited proposals for stone, and stone and concrete combined, for the dock at that yard. As a result of this invitation several favorable proposals were received, and on Feb. 6, 1899, the contract for a concrete dock, with rubble filling and lined with cut granite, was awarded to the firm of O'Brien & Sheehan, of New York city, for $875,000 for the dock proper. The separate bid for the electrical and other machinery added about $150,000 to this amount, bringing the total within the sum of $1,025,000 fixed by Congress.

Work has already been commenced on this dock, and it is to be completed within 30 calendar months. For the privilege of reproducing the accompanying plans we are indebted to the courtesy of the Chief of the Bureau of Yards and Docks, and the general description is taken from the specifications issued to the contractor.

The borings made at the site of the new dock show that at a depth of about 25 ft. below mean low water a bed of compact clay and gravel is encountered, with some thin sand strata, possibly containing water. The position of the new dock is about midway between the old stone dry-dock, finished in 1833, and the larger of the two "wet basins," and parallel to the old dock. The general dimensions of the dock will be as follows:

	Ft.	Ins.
Length on coping, from head to outer end of table	788	0
Length on coping, from head to outer gate-sill	750	0
Length on floor, from head to outer gate-sill	729	0
Length on floor, from head to inner abutment	689	0
Width on coping in body	114	0
Width on floor in body	72	0
Width on coping at abutment, least	101	8⅝
Width at entrance on mean high water level	100	0
Depth from coping to mean high water	5	2
Depth from coping to floor, in body	39	2
Draft over sill at mean high water	30	0

Under the terms of the contract this dock is to be built of concrete, with rubble stone fillers, and lined with cut-stone masonry, as shown in the cross-section illustrated. When the excavation has sufficiently advanced so as to fully expose the character of the underlying material, the government will decide whether piles shall or shall not be used under the dock; the present borings, however, would indicate that the soil is sufficiently compact to omit piling. A price for piling and framing, in accordance with plans made, was obtained in the bids submitted; to be separately considered. In addition to the dock, there will be a pump-house, one-story in height, built of granite, with steel roof-trusses and a copper roof. The necessary culverts and wells will be made of concrete and lined with glazed brick. There will be three main drainage pumps, of the centrifugal type, with separate electric motors, balanced and driven by vertical compound engines, and four steel boilers will be included in this plant. The steel caisson, or floating gate, with all its pumping plant and machinery, is included in the bid for the complete dock; but a separate item covers the steam generators in the central power-house, the pumps, engines, dynamos, electrical capstans and winches, and all piping and connections, and all machinery, excepting the machinery in the caisson. The contractor is also required to excavate a channel from the entrance to the dock, and one foot below the table end of the dock, to a point in the harbor where a corresponding depth is reached.

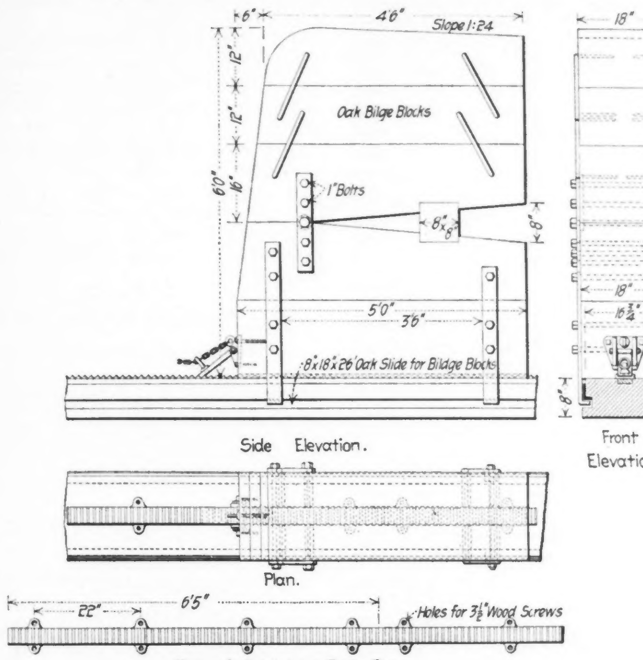
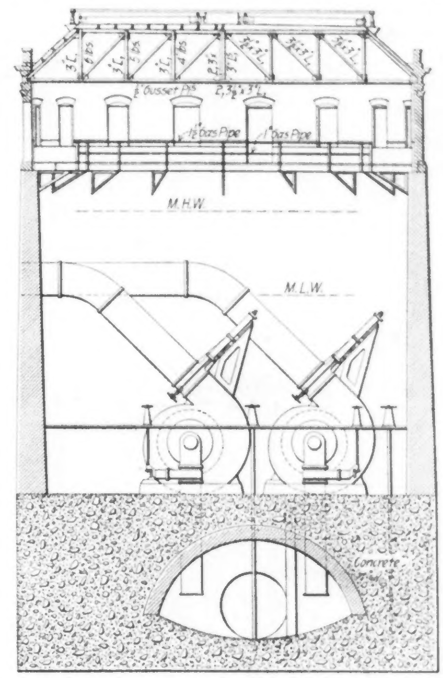


FIG. 6.—DETAILS OF BILGE BLOCKS, BOSTON DRY DOCK.

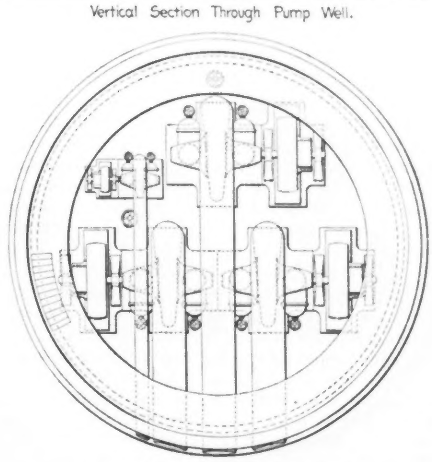
The concrete to be used in the dock is to be made of Portland cement; with one part of cement to two parts of sand and five parts of broken stone or gravel, all by measure. Special and stringent specifications are issued as to the seasoning, packing, storage and testing of this cement. The sand and cement is to be thoroughly and evenly mixed dry on close platforms, after which a spray of water is to be applied until the paste assumes a proper and uniform consistency. This mortar is then uniformly spread over the previously moistened gravel or broken stone, which has been disposed in an even layer on the platform, and the whole will be turned over at least three times and thoroughly mixed. This concrete will be deposited in the work in layers not exceeding 9 ins. in thickness and thoroughly rammed. To avoid all horizontal joints in this concrete work, the contractor is required, where the concrete is not too deep, to take up for construction a length that can be completed in one day, and finish off in steps to where the work is to begin on the following day. He must then start the work in a bed of 2 ins. of neat cement, after the surface has been well cleaned. All concrete started on a dry surface must be bedded in this 2 ins. of neat cement. No concrete can be used after it has commenced to set; and after it is in place and rammed, no stepping, working on, or walking over it will be permitted for at least 12 hours after it is deposited.

The stone masonry and lining in this dock will be granite in all wearing parts; but where covered by concrete the invert may be granite or limestone. The stone masonry of the walls and entrance will be laid in continuous courses of ashlar, patent-hammered on the face and 6-cut. Beds and joints must be dressed to form ⅜-in. joints, and the whole will be laid in Portland cement mortar, made one part cement to two parts of sand. The face joints must be picked-out to a depth of at least ½-in., and then pointed with Portland cement mortar, one cement to one sand, well pressed in and finished. The coping stones are not to be less than 2 ft. thick, 3 ft. wide and 4 ft. long, and they must have a smooth surface. Headers must occupy at least one-eighth of the face area of the walls, and hold their width so as to be at least 2 ft. wide at the tail. The invert is to be 3 ft. deep, and granite is to be used at the ends which show in the dock and receive the thrust and wear of shores, and limestone between these ends. The meeting faces for the caisson must be dressed perfectly smooth so as to form water-tight joints; and the stone must be worked out to form all angles.

As shown on the drainage plan, there will be four longitudinal subfloor culverts, extending from the head of the dock to near the abutment, where they join a semicircular cross drain of 6 ft. radius. The subfloor drains have concrete floors and sides; and the cross-drain has a concrete floor and arch, stiffened under the keel-blocks with steel I-beams; the cross-drain opens into the sump of the 8-ft. main drainage culvert leading to the pump-well. The entrance to this main drain is covered with an iron grating, 10 × 16 ft., with openings exceeding the total cross-section of the main drain. Another 8-ft. circular culvert of concrete lined with glazed brick, similar in all respects to the main drainage culvert, will lead from the pump-well, through the foundations of the dock and connect, 68 ft. beyond the axis of the dock, with a drain leading to the old dry-dock, No. 1. Both of these main-drains, at the points of entrance into the wall chamber, will be closed by balanced gate-valves mechanically operated from the working floor of the pump-house. The emptying culvert leads from the pump-house through the entrance wall to the dock; and this culvert rests on timber foundations and is of semicircular cross-section, with a radius of 9 ft. 6 ins.



Vertical Section Through Pump Well.



Plan of Pump Well Grating Removed.

Fig. 8.—Elevation and Plan of Pumping Plant, Boston Dry Dock.

The pump-house and well are built of masonry, with a cast-iron floor and a steel frame roof covered with glass and copper. The concrete foundation is about 50 ft. 6 ins. diameter, and about 21 ft. deep, resting on gravel and clay about 60½ ft. below the coping level. In this Portland cement concrete base is a water-chamber, about 30 ft. long, and formed by a brick arch of 12 ft. radius and an invert of 24 ft. radius. One end of this chamber connects with the 8-ft. main drain from the new dock; and the 8-ft. drain leading to dock No. 1 communicates with a branch chamber, of similar dimensions, leaving the main chamber about at its center. The suction pipes of the three main drainage pumps enter this chamber through the arch. Above this concrete base rises the circular wall of the pump-house, 43 ft. 6 ins. diameter, laid with hard burnt red brick in Portland cement, and faced inside with white glazed brick; the outer face of this well will be protected by 1 in. of asphaltum applied hot, and the inside surface of the wall must remain dry. About 8 ft. above the concrete base there will be a steel frame and cast-iron grating working floor.

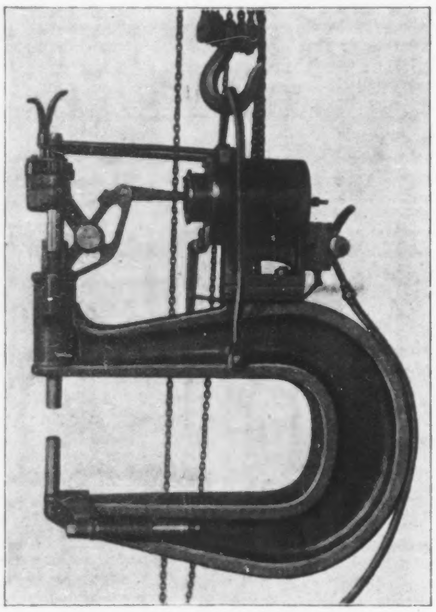


Fig. 1.—A Portable Pneumatic Riveter with a 36-in. Reach and an 18-in. Gap.
Havana Bridge Works, Montour Falls, N. Y.

The superstructure of the pump-house will be about 49 ft. outside diameter, and 20 ft. high, provided with doors, windows, gallery, stairs, etc. The walls will be rock-face and 6-cut granite, and glazed brick will be used for an inside lining.

The pumping plant will include three independent centrifugal pumps, with separate motors, for pumping out the dock; and one centrifugal drainage pump and motor. There will be two vertical, cross-compound, condensing, automatically governed engines, with each engine connected with two dynamos; and also four steel boilers. The pumps admit water on both sides of the disc, and the runner-shaft will be directly-connected with the armature shaft. The general plan calls for an average discharge for each pump of 43,000 gallons per minute; the minimum required mean discharge duty of the three pumps is thus 135,000 gallons per minute, measured while pumping from mean low water to floor level. The efficiency of the machinery in the pump well must not be less than 55%. The main pumps, as designed, contemplate a 6-vane runner, 79 ins. diameter, a single 45-in. discharge pipe, and two 32-in. suction pipes, joined by quarter-turn bends to each side of the pump-casing, and inclosed runner, so as to balance the runner and avoid end thrust. There will be three double-gate valves to each pump; one on the discharge and one on each suction pipe. The drainage pump will have a 34-in. runner, and be direct-connected to an electric motor placed on the same bedplate; the suction and discharge pipes will be 14 ins. diameter.

There will be four 200-kilowatt dynamos, of the compound wound, direct current, constant potential, 125-volt type, arranged for direct connection with overhung armatures. The fields are to be multipolar; and the commercial efficiency of the dynamos must not be less than 92% with full load; 90% with half, and 85% with quarter load. One 300-kilowatt motor will be directly-connected to the runner-shaft of each of the three main pumps; and one 50-kilowatt motor will drive the runner-shaft of the drainage pump. Each engine, running two dynamos, will run, condensing, with 100 lbs. initial steam pressure and 26-in. vacuum, and develop continuously 600 I.-HP. The working boiler pressure will be 125 lbs. gage, and the speed of the engine is to be 150 revolutions per minute, with a variation in speed not exceeding 1% with any change of load.

The steel caisson, or floating gate, will have an extreme length of 104 ft. 2 7-16 ins.; molded breadth, 22 ft.; and a depth of 36 ft. 5 ins. from the bottom of keel to the under side of upper deck. It will be built, as far as possible, of open-hearth steel, with welded members of wrought iron. The keel and stems must be 30 ins. wide, outside of channels, and made of two 15-in. by 55 lbs. channels connected to side plating by rivets spaced 4½ ins. on centers. The transverse frames are spaced 24 ins. on centers; alternating 5 × 3½ ins. by 13.6 lbs., and 5 × 3½ ins. by 17.8 lbs. Z-bars. The deck stringers and beams and floor plates, etc., are shown on the plan. The channel for gate packing, running the entire length of the keel and stems along the outer edge on both sides of the caisson, is steel, 10 ins. by 25 lbs., fastened by ⅞-in. rivets. Inside these channels is fitted a thick rubble packing secured by an oak timber 5 ins. thick. In the hull of the caisson will be 13 20-in. valves connected with 20-in. wrought-iron culverts, for flooding the dock, and there will also be two 20-in. sinking valves for use in settling the caisson into place. The centrifugal pump in this caisson will have a capacity of 3,000 gallons per minute with mean lift, and it will be driven by an inverted, vertical engine of acceptable design. The bottom of the caisson will be filled with Portland cement concrete ballast, and there will also be sufficient movable cast-iron ballast to give the caisson a floating draft of 18 ft. 6 ins.

The oak bilge-blocks and slides are fully shown in the plans. The six electric capstans, three on each side of the dock, will each be operated by a 22.5-K-W. motor, contained in a pit 5 ft. deep under the capstan. Three electric winches, of about 25 K-W. each, will also be installed, one at the head of the dock and one on each side of the entrance. There will be a separate underground circuit leading to these capstans and winches from the power plant.

A PORTABLE PNEUMATIC RIVETER.

We illustrate herewith a new form of toggle-joint pneumatic riveter which embodies several features of special interest.

It will be seen that the riveter consists of the usual spradle or U-frame and stake die, reciprocating plunger and air cylinder. Each of these parts, with the exception of the frame, is somewhat out of the ordinary. The stake die has a projecting side piece, which is hinged to the yoke, and is provided with a catch device, so that it can be locked in its proper position or folded back to permit the horn to span stiffener angles or get into out-of-the-way places.

The air cylinder is mounted on top of the yoke, and has a sleeve or trunk piston (Fig. 2). This construction is adopted for two reasons. The first being that as only a small amount of work is necessary to raise the plunger, the smaller area of the piston effects a saving of the compressed air. The other reason is that the operation of the toggle-joint requires a certain amount of freedom on the part of the piston rod which is permitted by the hollow trunk. At the back of the cylinder is a striking pin which projects through a suitable stuffing-box and automatically throws the controlling valve to the off position when the piston reaches the end of the return stroke.

Referring to Fig. 2, it will be observed that the toggle-joint is composed of one straight link and a lever resembling a walking-beam, the upper end of which is connected to the piston rod. This arrangement doubles the power of the air cylinder, which is 10 ins. in diameter for all sizes of riveters, and uses air at from 60 to 70 lbs. The pin at the center of the toggle is of peculiar construction, and is really the most important feature of the whole riveter. Ordinarily as a toggle-joint closes towards the straight line joining the outside bearings, the force exerted gradually increases, and finally becomes infinite, theoretically. This feature often proves troublesome, particularly when there is a variation in the thickness of metal being riveted, since it is difficult to adjust the plunger advance for each rivet. With the riveter under consideration, the center pin is in reality eccentric, and after the ram has moved forward until the toggle is almost closed, this pin automatically shifts, so that the ram continues to advance, but with a practically constant pressure. In this way, after properly setting the adjustable head, the plunger can be advanced with increasing force until the rivet head is formed, after which the advance is with constant pressure until the contact pressure becomes equal to the force of the advancing plunger.

The adjustment for different thickness of material is effected by two heavy screws, one on each side of the plunger, which are provided at their upper ends with spur gears meshing into a third smaller gear with a crank for turning. Each turn of this crank advances the plunger die ¼-in. The controlling lever operates a simple slide valve, shown quite clearly in Fig. 2.

For the material from which this description has been prepared we are indebted to Mr. James A. Shepard, Havana Bridge Works, Montour Falls, N. Y.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Hydrostatic Test of Steam Boiler.

Ellen Bell, administratrix of John Bell, deceased, sued the Consolidated Gas, Electric Light, Heat & Power Co. for damages caused by alleged negligence resulting in the death of her intestate. Deceased was a fireman, and at the time of his death had been so employed for seven years, during all of which time he had worked for defendant. Defendant used in its power house a horizontal tubular boiler of the Babcock & Wilcox make.

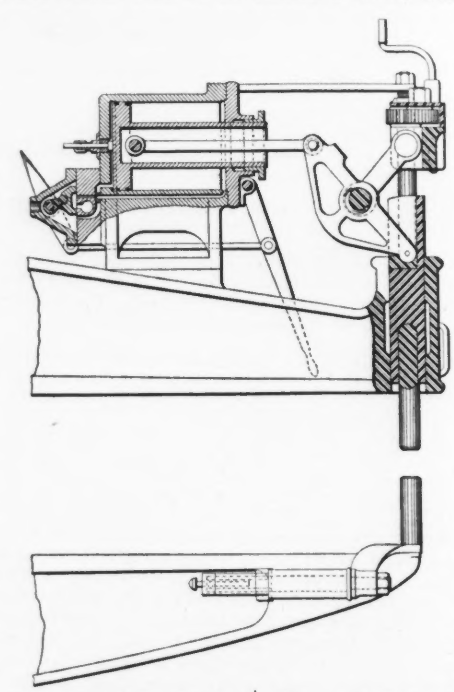


Fig. 2.—Section of Cylinder, Valves, etc., Showing Details of Eccentric Toggle Joint.

The water was in tubes, at the end of which caps were fastened by bolt and nut so that they could be removed and the tubes opened whenever desired, from time to time, when it became necessary to clean the boiler. It was conceded on the trial that the boiler was of proper design and style, and that its parts were in good condition. A day or two before the accident causing Bell's death the boiler was cleaned, and under direction of the engineer, who had general charge of the plant, Bell replaced the caps. When water was run into the boiler and fire started, the engineer testified that he directed deceased to go behind the boiler and see if there were any leaks, and there was other evidence that the engineer directed him to go under the boiler to the mud drum. While deceased was under the boiler one of the caps blew off, permitting steam to escape, injuring him so that he died the following day. Evidence was given by experts for plaintiff to show that the replacing and fastening of the caps was a work requiring considerable skill; that the bolt, being in a horitontal position, its weight tended to make it sag, and that it was a work of great difficulty to have the threads on the bolt fit exactly into the threads of the nut, and that if the bolt was not exactly in the proper place, the torsional strain in screwing it up and tightening the cap was liable to injure and weaken the bolt. The experts testified that for this reason, whenever the caps were taken off and replaced, the boiler should be subjected to a hydrostatic test before it was attempted to make steam in it, and that this test would show whether the caps were on tight and whether the bolts had been weakened. The failure to make such test was the negligence alleged. The case turned on the law regarding the duties of a master to a servant, and the Supreme Court, Appellate Division, Second Department, New York, held that a general practice of subjecting boilers to a hydrostatic test after cleaning them was not conclusive on the question of a master's liability for the death of his servant from a defect which could have been discovered by such test, as the master was not bound to employ the latest and most improved methods of testing appliances; that such a master, who employed a competent engineer, was not liable for the death of his fireman, through a failure to make such test, and that an engineer was a fellow servant of a fireman engaged with him in operating a stationary engine. Bell vs. Consolidated Gas, Electric Light, Heat & Power Co., 56 N. Y., Supp. 780.

Necessity of Notice in Public Contract.

Where under a contract a party was to begin work on such day as the Commissioners of Public Parks might designate, before he was bound to begin, the Commissioners were bound to designate the day; and proof of such notice was necessary to enable the Commissioners to retain any portion of the consideration for failure to complete the work within the time required by the contract. Dwyer vs. City of New York, 55 N. Y. Supp. Rep. 930.

Liability of City and Company for Broken Electric Wire.

Where an electric light wire in a city breaks and falls down and remains in the street for several weeks, thus constituting a dangerous obstruction to travel, and causing injury to a passerby, both the city and the electric light company are presumed from the lapse of time to have knowledge of its condition and dangerous character, and both may be joined in an action for damages for injuries resulting from their negligent omission to cause the wire to be repaired. Kansas City vs. Filee (Kan.), 55 Pacific Rep. 877.

Invalid Restrictions in Public Contract.

A contract for street paving at a certain price per square yard which reserved the right to the Superintendent of Streets to require a greater or less quantity of a certain material in the work, thus affecting the profits on same, is invalid, as discouraging competition on public work. Cal. Imp. Co. vs. Reynolds (Cal.), 55 Pac. Rep. 802.

Street Railways and Abutting Property.

The operation of an electric railway, with municipal consent, along a public street, conforming to its grade, is not an additional servitude outside of the public casement, for which the owner of the fee of the street is entitled to compensation. Birmingham Traction Co. vs. Birmingham Ry. and El. Co. (Ala.), 24 So. Rep. 502.

CLEANING CAST-IRON WATER PIPE WITH SCRAPERS AT ST. JOHN, N. B., AND BOSTON, MASS.

The diminution of the carrying capacity of water mains is so important a factor in water-works design and operation that it is strange so little has been done in this country to remove the rust and other acumulations causing it.*

The most recent work of this character, so far as we know, was done at St. John, N. B., in 1897 and 1898, by Mr. Wm. Murdoch, Engineer of Water-Works, and is described at length in the June number of the "Journal of the New England Water-Works Association."

A portion of the water supply of St. John is brought to the city from Little River through three lines of cast-iron pipe, each 4.3 miles long. No. 1 was laid in 1851 and is 12 ins. in diameter. Nos. 2 and 3 are 24 ins. in diameter, and were laid in 1857 and 1873, respectively. Nos. 1 and 2 were not coated; No. 3 was treated by Dr. Angus Smith's process. The difference in level between the water surface (elev. 160) at the intake and the highest area (elev. 130) supplied by these mains is only 30 ft. With the No. 3 main closed, the two older pipes had become so badly incrusted that the whole area above elev. 80, comprising 200 acres, with a population of 8,500, was without water.

It was decided in the summer of 1897 to clean the mains by scraping. Iron hatch boxes, shown by Fig. 1, were designed, cast and built into all three mains, nine in the two 24-in. mains, and four in the 12-in. pipe. Each box weighs about 3,300 lbs., takes 26 square-necked bolts and a gasket of 18 ft. of Tuck's 1¼-in. round packing. Outside the city, each box was enclosed in dry rubble masonry, covered with timber. Within the city, the covering consists of arched masonry in cement, with an iron manhole.

A 24-in. scraper was also designed and built. The view, Fig. 2, shows the scraper used in 1898, which differed somewhat in detail from the first one, the cutting arms being stiffer and designed to avoid clogging. The two pistons shown in Fig. 2 are built up of birch, bolted and flanged, and connected with a piece of 3-in. wrought-iron pipe. The two sets of cutting arms, mounted on an iron rod, are made of steel, the knives being of forged steel, designed to bend and pass over such obstructions as cannot be removed.

The old 24-in. main, the only one yet cleaned, is described by Mr. Murdoch as having had "an internal coating of tubercles varying up to about 1 in. in height, closely packed all over the interior surface of the pipe and resembling in appearance that of a coarse pebbly walk." The average thickness of the deposit is given as ¾-in., or about 330 cu. yds. in 22,700 ft.

The net result of cleaning the old 24-in. main is to make it and the old 12-in. pipe capable of delivering water to a level 141 ft. above high water datum in the harbor, instead of to only 80 ft., as before.

A total distance of 94.5 miles was traversed by the scraper through the 4.3 miles of pipes, more trips being made in some sections than others. The cost of operation was $274. This is about $64 per mile (or 12 cts. per ft.) of pipe and $6.38 per mile of run. The cost of the hatch boxes on this line was about $1,513, or about $350 per mile of main. The scraper cost about $40.

The material detached by the scraper was flushed out of the mains, the water being allowed to waste for some time after the scraper passed through.

The scraper was partially wrecked once, through having been repacked with leather stiffer than that formerly used, which resulted in stoppage against a joint made when the hatch box was inserted. A jack screw was used to start the scraper along. When the scraper came through, it was minus one piston. It was learned that this piston had broken, as a result of using the jack screw, and been left behind, partially obstructing the flow. The piping, fortunately, was so arranged that the current could be reversed, which brought the lost piston back to its original starting point.

The total weight of the scraper is only 263 lbs. The operating force consisted of a foreman, one mechanic, two watchers, six assistants and two teams. The latter were used to transport the scraper and men back to the starting point. The assistants were stationed, two each, at the valves close by the flushing stations. The watchers followed the scraper down the pipe. Outside the city the scraper could be heard moving along at a distance of 30 ft., the pipes being covered 3 to 6 ft. Within the city the noise of traffic drowned that of the scraper, so there was nothing to do but to wait for its appearance at the hatch boxes.

Mr. Dexter Brackett, M. Am. Soc. C. E., supplemented Mr. Murdoch's paper by the following interesting account of similar work, on smaller pipe, done in Boston in 1886 and 1887:

The pipes laid in Boston from 1848 to 1868 were uncoated, and the interior surface of the pipes is covered with a coating of tubercles from ⅜ to 1¼ ins. in thickness. This coating, as proved by Mr. Murdoch's statistics, very seriously affects the delivering capacity of the pipes, and, in the case of the smaller sizes, renders them practically useless for fire supply.

The pipes cleaned in Boston were not the supply mains, but the distributing pipes in the streets, the sizes cleaned being 6 and 12 ins. in diameter. In cleaning these pipes the conditions were somewhat different from those of Mr. Murdoch, whose work was done on a pipe of larger size, where there were probably few, if any, service pipe connections. As many of the service stop-cocks project into the pipes from ½ to ¾-in., it was necessary to have the scraper arranged so as to pass by such obstructions, and at the same time remove the coating of tubercles. The machine, which was very successfully used, consisted of a flexible central shaft about 3½ ft. in length, composed of coiled steel springs connecting small castings, to which were hinged two sets of steel scrapers, arranged radially around the shaft about 12 ins. apart. The scrapers were kept against the sides of the pipe by coiled springs, which permitted them to turn back so as to pass taps or other obstacles. Back of the scrapers were two rubber pistons placed about 2 ft. apart so as to ensure a pressure on the machine when passing branches. The scraper was operated in a manner very similar to that used by Mr. Murdoch, except that no hatch boxes were placed in the mains. A section was cut out of the pipe long enough to receive the scraper, which was then inserted, and the joints made with lead in the ordinary manner, except that clamp sleeves were used so that the section could be again easily removed and the scraper inserted if desired. A similar piece was cut from the pipe at the other end of the main to be cleaned, and the scraper was forced through the pipe by the ordinary water pressure, which varied from 30 to 45 lbs.

As occupants of buildings on the line of the pipes were without water while the work of cleaning was in progress, and as it was not thought advisable to pass the scraper through valves, the pipes were cleaned in lengths averaging 1,000 ft. The scraper generally passed through this distance in from three to four minutes, or about as fast as a man would walk. In a few instances the scraper was stopped by obstructions in the pipe, the one causing the most trouble being lead which had run into the pipe at a joint. The water issuing from the open end of the pipe was the color of ink for from five to ten minutes after the scraper had passed through, and it was permitted to run until it became clear, after which the section of pipe was replaced and the valves opened. Some difficulty was experienced from the stopping of service pipes and house plumbing by rust forced into the pipes by the pressure of the water following the scraper, but this difficulty could be generally overcome by applying a force pump to the house plumbing and forcing the obstructions back into the main.

By this method the tubercles were removed from 58,000 ft. of 6-in. pipe at a cost of 14 cts. per ft., and from 20,300 ft. of 12-in. pipe at a cost of 20.6 cts. per ft. These prices include 5 cts. per ft. royalty paid for the right to use the scraper.

As was the case at St. John, a great improvement was made in the delivering capacity of the pipes by the removal of the coating of tubercles. Experiments were made to determine the friction in the pipes both before and after cleaning under different rates of discharge. The discharge was measured by means of a Deacon meter, and the friction head from readings of Bourdon gages attached to the fire hydrants. Very great accuracy was not expected in these experiments, but they show very well the great loss in discharging capacity, caused by the coating of tubercles and the gain from the cleaning. It will be noticed that the discharge of the 6-in. tuberculated pipes was from 25 to 35% of the quantity which a clean-coated pipe might be expected to deliver under the same head, and that the discharging capacity of the pipe was more than doubled by the removal of the tubercles.

Effect of Scraping 525 ft. of 6-in. Uncoated Pipe, 38 Years Old, at Boston, Mass.*

Observed head, ft. pr 1,000.		Velocity, ft. per sec.		Observed discharge, gals per min.		Value of c in formula $v = c\sqrt{R\,I}$.		Calculated discharge clean pipe same head Darcy's formula.	
Before.	After.	Before.	After.	Before.	After.	Before.	After.	Before.	After.
1.30	2.70	0.38	0.76	33.3	66.6	29.5	41.5	120	170
2.50	1.50	0.57	0.95	50.0	83.3	32.2	68.8	165	125
6.90	1.50	0.95	1.13	83.3	100.0	32.3	82.5	[illegible]	125
14.40	3.80	1.13	1.51	100.0	133.3	27.1	69.4	395	205
19.20	4.20	1.32	1.70	116.6	150.0	27.1	74.2	455	215
25.40	6.50	1.51	2.08	133.3	183.3	26.8	73.1	525	265
33.80	9.40	1.70	2.46	150.0	216.6	26.1	71.8	600	320

*The two original tables have been combined for convenience.—Ed.

STORAGE BATTERY CARS are to be used on the Dry-Dock & East Broadway street railway in New York, instead of the present horse cars. It was at first proposed to use the conduit electric system, but this was abandoned on account of the liability of flooding of the conduit, the line following the East River water front. It is stated that next spring the twelve miles of double track will be rebuilt, the track being laid with 100-lb. girder rails.

THE IRISH CHANNEL TUNNEL, referred to editorially in our issue of July 13, would not avoid the break in a continuous journey, for the reason that while the English railways have the standard gage of 4 ft. 8½ ins., the Irish railways have a gage of 5 ft. 3 ins. On the whole, the project for a tunnel is hardly less impracticable than the project for a huge embankment across the Irish channel, and neither project would be of much commercial importance or of much benefit to Ireland, which benefit is the ostensible aim of the well-meaning, but ill-informed, projectors.

*The principal attempts of the sort recorded in technical literature since 1880 are as follows:

"The Internal Corrosion of Cast-Iron Pipes." Eng. News, Sept. 17, 1881. Abstract, with illustrations, of a paper read before the Inst. C. E., by B. Jamieson. Various devices shown and tables of cost given. Full paper, Proc. Inst. C. E., Vol. LXV., p. 323.

"On the Removal of Incrustation in Water Mains. A Description of the Operations Performed in Halifax, N. S." By E. H. Keating, M. Am. Soc. C. E. Brief abstract under report of meeting, Eng. News, March 18, 1882. Full paper, Trans. Am. Soc. C. E., Vol. XI., p. 127 (April, 1882).

"Water Pipe Scraper." Brief illustrated description of Clayton scraper (with brush) used at Bradford, Eng. Eng. News, April 10, 1886.

"Notes on Some Matters Connected with the Distribution of Water in Cities." By S. Tomlinson, Assoc. M. Inst. C. E. Contains brief illustrated descriptions of a scraper for small pipes, pushed along by manual labor, and of the larger sized scrapers, operated by the water pressure; also some notes on the use of scrapers at various places, and cost of same. Proc. Am. W.-Wks. Assoc., 1889, p. 103.

Discussion on Scraping Water Mains. Jour. N. E. W.-Wks. Assoc., Vol. V., p. 21 (Sept., 1890).

"The Removal of Corrosion from Water Mains." By Herbert Henderson, Assoc. M. Inst. C. E. Illustrated description of English form of scraper, with cost and details of operation for 20 cities; also cut of American scraper for oil pipes. Eng. News, Aug. 2, 1894; Proc. Inst. C. E., Vol. CXVI., p. 307 (1893-4).

Discussion on Cleaning Water Mains, Proc. Am. W.-Wks. Assoc., 1896, p. 56.

"Cleaning a Water Main in St. John, N. B." By Wm. Murdoch, Engineer Water-Works. Jour. N. E. W.-Wks. Assoc., Vol. XIII., p. 333 (June, 1899). Abstracted here.

REDWOOD BLOCK PAVING WITH ASPHALT CARPETING, AT OAKLAND, CAL.

Redwood block paving with a thin asphalt carpet, is described in the last biennial report of Mr. M. K. Miller, Superintendent of Streets of Oakland, Cal. The work was done on East 12th, between 1st and 11th Avenues, the width being 25½ ft., and the length 3,650 ft. The blocks were boiled in asphalt, then laid on 6 ins. of concrete after the latter had been painted with a thin coat of hot asphalt. The joints were filled and the surface covered to a depth of about 1-16-in. with boiling asphalt. The blocks are 4 ins. deep, 6 ins. sq., laid snug together in even rows at right angles to the curb, with joints broken at least 1 in. The blocks were cut from seasoned butt-cut redwood. They varied in weight from 2 to 6 lbs., many of them being "heavy with the natural wood acids." Mr. Miller states that this variation caused some uneasiness at first, but this was quieted by investigations made before the work was done. The tannic acid in the wood is held to be a preservative. The asphalt carpet is designed to be the wearing surface, and to be renewed as often as necessary. It is said that redwood paving blocks have given good satisfaction during three years' service in San Francisco, but they are considered as still in the experimental stage. It is expected that a portion of the asphalt carpeting will have to be replaced every two or three years, and perhaps oftener, where travel is most concentrated.

Further particulars regarding the dipping and laying of the blocks is given in the report, as follows:

During the early part of the work, observations were made as regards many of the details connected therewith. It was soon observed that the blocks, when delivered upon the ground, and exposed to the weather, sun-checked very rapidly. This is particularly true, naturally, of the drier blocks. Just what ultimate effect the sun checks will have on the pavement is problematical. It was supposed that the checks would be thoroughly filled and sealed with asphalt by the dipping process; experience proved this not to be the case. Sun-checked blocks, after treatment, when submerged in water, were found to take in a comparatively large amount of the fluid. The boiling asphalt would run into the checks, but evidently ran out again, for they were found not to be filled and sealed. The asphalt mixture in which the blocks were to be dipped was a matter for serious consideration. The specifications provided that the mixture should be 50% hard asphalt mixed with 50% California liquid asphalt. The blocks came out of this mixture in an unsatisfactory condition. They were sticky and glazed on the ends, and the asphalt did not penetrate into the fiber of the wood more than 1-16-in., whereas more than ¼-in. penetration was desired. The bath was changed to 80% of hard asphalt and 20% of the liquid flux, with much more satisfactory results. This mixture is considered much superior to the former, inasmuch as the hard asphalt is refined and contains the more permanent oils. The temperature of the bath was found also to be a matter of importance; when allowed to get below 350° F., some of the blocks would come out unsatisfactorily, sticky and glazed on the ends, and with little penetration of the asphalt into the fiber of the wood. A temperature from 350° to 400° F. should be maintained while the blocks are being dipped. The time of submersion in the bath is not so important a matter as might be expected. If sufficiently hot, say at a temperature of 375° F., 3 to 5 minutes' submersion appears to give as much penetration as 15 minutes. The blocks in this pavement were submerged not less than 6, nor more than 10 minutes. Experiments were made by submerging the blocks in the bath at 5, 10, 15 and 30-minute 1, 6 and 10-hour intervals.

The dry blocks, if submerged longer than 15 minutes, are considerably checked by the force of the heat. When left in the bath several hours, they come out badly split and unfit for use. Blocks submerged but five minutes, when split open, are found to be too hot throughout on the inside to handle comfortably with bare hands. The effect of the heat is, of course, to dispel the moisture in the blocks, and in some cases the blocks, when removed from the bath, although having absorbed about 3 ozs. of the asphalt, actually weigh less than before being treated.

As previously stated, blocks dipped in a bath of too low a temperature would come out sticky and glazed on the ends and with but little penetration into the fiber of the wood; had the penetration been sufficient, the glaze on the ends would not have been objectionable; on the contrary it would have insured the blocks being impervious to water. It was found that the treated blocks after having been laid on the concrete foundation would check by the force of the sun heat even more readily than before having been treated. To prevent this the first course of grouting material should be applied to the pavement within a few hours after the blocks have been laid.

Before laying the blocks the concrete foundation is given a thin coat of liquid asphalt, applied at a boiling temperature. The practical utility of this coat of asphalt is uncertain; it, of course, does no harm, but it is somewhat doubtful if the benefits justify the additional expense. One of the essential points to be observed in this pavement is to preserve the blocks from the absorption of moisture, and the idea of coating the foundation with asphalt was to seal the concrete and thereby prevent any moisture from getting into the blocks from that source. Considering, however, that the blocks themselves are supposed to be impervious to water after treatment and that the spaces between the blocks are all thoroughly filled with asphalt cement, besides a wearing coat of asphalt cement and sand on the surface of the blocks, it appears quite impossible for water to get in under them. The grouting material was composed of 80% of hard and 20% of liquid asphalt, to which was added 30% of carbonate of lime. The carbonate of lime was first mixed with 15% of liquid asphalt. The moisture contained in the carbonate of lime, when applied direct to the asphalt mixture, caused it to boil over the sides of the kettle, and it was therefore found necessary to mix it separately with half of the desired quantity of liquid asphalt. As much as 50% of it can be mixed with asphalt, and when heated to a boiling temperature the fluid will run like water.

It was found necessary to apply the grouting material in not less than three courses; spaces between the blocks which appeared to be thoroughly filled immediately after the first coating was applied in the course of two or three hours were found to be partially empty, the grout having settled down into the open spaces. The second coat also failed to thoroughly fill the crevices, and, in some instances, even the third coat after final settlement of the grout left some of the spaces not entirely filled. If the first coat was poured on too freely it would tend to float an occasional block, and considerable trouble was experienced on this account. If the grout once starts in under the block it will gradually lift it and in the course of a few days it will displace it as much as 1 in. vertically.

The grouting material when cold glues the blocks together with a tensile strength of over 200 lbs. per sq. in.; on a hot day it softens considerably, however. After the final course of grout has been applied the pavement is covered with a coat of hot sand about ¼-in. in thickness; this sand is gradually taken up by the asphalt, which thus becomes hard and firm, leaving the blocks carpeted with about ¼-in. of what is really bituminous rock. This carpet is the wearing surface of the pavement, and experience has shown, as previously stated, that it will sustain ordinary wagon traffic on a city street for at least two or three years. It can be renewed at an expense of less than ½ ct. per sq. ft., and it is very essential that it should be renewed as often as necessary, particularly where the blocks are of redwood. Where hard wood is used it would not be so essential, but redwood is soft and would speedily give way under the forces of impact and abrasion when once the fiber of the wood is exposed.

In the construction of this pavement no space was left at the curbs for any expansion of the blocks; in fact, no appreciable expansion is anticipated. The blocks are supposed to be impervious to water under ordinary conditions, incident to rainfall. The carpet of asphalt which protects the fiber of the wood from wear is intended to be maintained by renewing it as often as necessary. If not maintained, wagon traffic will, of course, eventually cut into the blocks, which will then absorb moisture and expand more or less. If the pavement fails, however, on this account, it will be due entirely to the negligence of the authorities, and cannot be charged to any fault in the design of the pavement. Experience with this pavement in San Francisco has demonstrated that the blocks, after the asphalt carpet is worn off, will stand an immense amount of traffic. The asphalt,, absorbed by the blocks, glues together the fibers of wood, rendering it tough, and infinitely more durable than untreated blocks.

During construction every block passed through the hands of a reliable inspector before it was subjected to the asphaltic bath. About 10% of the blocks delivered upon the work for use by the contractor were condemned. Personal attention was given to the work throughout from beginning to end, and it can be confidently asserted that if there is any merit in the redwood block pavement over and above other pavements that the people of Oakland will get the benefit thereof in this case.

THE PRESERVATION OF TIMBER.*

By Samuel M. Rowe, M. Am. Soc. C. E.

In the United States, as well as foreign countries, so much attention has been given to this matter that the utility of treatment for prolonging the life of timber exposed to severe action of the elements can no longer be called experimental. In this country the rapid consumption is causing an increase in cost and a rapid reduction of the supply of timber suitable for such purposes as ties and bridge timbers, and some idea of this demand is to be had from the following figures, which tend to explain the present increase in cost and the shortness of supply:

There are now in the United States about 185,000 miles of railway, which, when second, third and fourth tracks and sidings are added, will aggregate 245,000 miles. Each mile requires 2,640 ties, on the average, making a total of 650,000,000 ties. The average life of ties does not exceed eight years; oak a year or two more, but the softer woods much less. Assuming that the mean life is nine years, it would require for annual renewals 72,000,000 ties, nearly 300,000,000 cu. ft. or 3,600,000 ft. B. M. of timber. Each annual demand for ties alone must strip half a million acres of our best forests, and the rate of renewal is about 140 cross-ties every minute, night and day, throughout the year.

Until quite recently white oak has been specified by many railways, the softer woods being rejected, but in other cases, where oak was not obtainable, arbor vitae has been accepted on account of its lasting qualities and lightness. Its failure to resist crushing, however, makes tie-plates necessary. In the middle and far West recourse is had to the pines and the softer woods, the life of which is perhaps not more than half that of oak; in this case the cost of renewals very quickly becomes a matter of importance, reaching 25% per year in some known cases. Another feature deserves attention. The demand for nothing but the soundest and best oak results, to some extent, in the destruction of the softer and less valuable timbers in the scramble for the latter timber; making a still further draft on the timber stock, which is a total loss. The improvidence here practiced will be better appreciated when it is shown that much of this wasted timber can be made to serve equally as well as the best oak and last twice as long.

The three best-known processes for preventing timber, and any one of which is effective in this direction, are the Burnett, the zinc-tannin, and the creosote or dead-oil process; the basis of the two former is chloride of zinc. There is probably no question but that the creosote process is the most effective, but its great and increasing cost generally tends to inquiry in the direction of a cheaper method or agent. The chloride of zinc process has so far met this and passed through a sufficient test to show its efficiency and reasonable cost.

In all these processes the timber is first prepared for the absorption of the chemicals. So far steam has been used for this purpose at such a temperature as will not injure the fiber of the wood, but still be hot enough to permeate the pores of the timber and start the natural saps; freeing the cells preparatory to the extraction of the sap by vacuum after steam is withdrawn.

The second step common to the three processes is to let the solution containing the chemicals into the retort without admitting air, so as to give every facility for rapid absorption. Then by a force pump additional pressure is put on the solution, generally up to 100 lbs. per sq. in., under which the charge is held for some hours, the time varying according to the character of the timber.

With the creosote or the Burnett process, withdrawing the solution completes the process. With the tannin process the charge is subjected to a further similar contact with a solution of glue, which, being withdrawn, is replaced by a solution of tannin extract; both of which are subjected to pressure as with the chloride application. Generally the glue is mixed with the chloride solution, thus saving one operation, but the preponderance of reason seems to be on the side of the separate application of the glue. It is reasoned that the chloride will be more viscous with glue added, and hence will not be absorbed so freely. Another weighty reason is that as the glue and tannin absorption, being largely superficial where most needed, there is no need for the glue to penetrate deeper than the tannin with which it is to combine; and, indeed, should it go further than the tannin, the gelatine not being neutralized by combining with the tannin, may be deleterious, and become an agent of destruction instead of a preservative. The Wellhouse, or zinc-tannin process, from which good results have been secured, has been to apply the glue with the chloride so that this question may not be deemed vital.

A block of treated wood was subjected to a test as to its absorbing power along with a block of untreated timber, both being immersed in cold water. Both pieces were of heart timber, and there was little or no observable difference in density. The untreated timber absorbed water much the more rapidly at first, but afterwards losing, in its rate of absorption, the treated block reached and passed it. This would seem to indicate considerable disturbance to the pores of the wood by the treatment, and also some loosening or parting of its fibers. In this connection it is well to say, with regard to the efficiency of the described operation, that what was secured by natural absorption of clean water in 30 days, is secured in this treatment by four hours' steaming and a like time with 100 lbs. pressure on the solution.

The glue and tannin are added to the Wellhouse process with a view to plug up the outer pores of the stick, protecting the chloride, which is very soluble, from wasting out by repeated wetting and drying, as happens in the case of railroad cross-ties in seasons of rains. The

*Abstract of a paper read before the Western Society of Engineers, July 5.

Burnett process uses the chloride in much the same quantities, and where the ties are laid in a dry country they show excellent results. The Southern Pacific Ry. has used the Burnett process for a number of years, and as a result has brought its cross-tie renewals down to a little over 4%, which indicates a life of 20 years, and this largely with soft timbers.

As before mentioned, soft timbers, short lived without treatment, can thus be made useful and lasting, no doubt taking the absorption more freely than hardwoods, yet, it is in no wise conceded that soft woods alone should be treated. It is believed that experience will show that the hardwoods and the heart timber of the pine, usually retained for other purposes than for cross-ties, will take sufficient; and that, all in all, they are valuable about in proportion to their density and maturity of wood and not in proportion to the amount of chloride or other antiseptic absorbed.

In calculating the amount of antiseptic necessary, the average character of the timber must be considered. Usually from 1½% solution for very dry and open grained pine, to 3% for obdurate or green timber is deemed sufficient. About ¼ to ½ lb. of pure chloride per cu. ft. of timber is deemed sufficient, and the strength of the solution is governed by the limit of absorbing power of the timber. It is believed possible to benefit the best timber that is offered. Nine years is a high average life for a good white oak, probably too high, but it is believed that these same ties can be made to last 15 years. Seasoning a year under shelter will do much toward it, as well as vulcanizing, or steaming and drying; and if a pine tie, that usually goes to pieces in less than 5 years, can be found after 13 years, to be good for three or four years, then surely a white or burr oak tie can be made to last 20 years.

Hemlock ties have been seen that were put in during construction and entirely replaced in 8 years, while treated hemlock ties, after 8 to 12 years, were still in the track and largely serviceable.

Concerning the subject of timber preservation, engineers are generally but imperfectly informed. Much of it has been done under patents involving some degree of secrecy, and to further complicate matters very imperfect records have been kept by those using the timber; so that much that might be said is involved in uncertainty, and for this reason statements have necessarily been kept inside the facts.

The first cost of the treating works deters many railways from adopting some process of wood preservation, and it is only by its importance being impressed upon those in authority that this difficulty can be overcome.

CHANGE OF GAGE ON THE COLUMBIA & WESTERN R. R. (CANADIAN PACIFIC RY. SYSTEM.)

The Columbia & Western Ry., extending from Trail to Rossland, B. C., is 13.6 miles long, and was built during the winter of 1895-96. It had steep grades and sharp curves, and attained an elevation of 2,300 ft. in the 14 miles from the wharf track at Trail to the railway ore bunkers at the Le Roi mine, three miles beyond Rossland. The grade was 4% on tangents, compensated 0.04% per degree on curves. The maximum curves were of 25°, and these numbered 38, with an aggregate length of about three miles. Two switchbacks were introduced, one between Trail and Smelter Junction, and the other at Tiger Gulch. The track had a gage of 3 ft., and was laid with 6-ft. ties and 28-lb. steel rails. The width of roadbed was 10 ft. in cuts and 9 ft. on embankments.

In 1898 the railway was purchased by the Canadian Pacific Ry., to form a part of its new line through the Crow's Nest Pass and the Kootenay district. Under the new management the road has been largely rebuilt, the maximum curvature being reduced to 20°, and the roadbed being widened to 16 ft. in cuts and 14 ft. on embankments. Four of the eleven trestles were filled in, and the others are strengthened. The contractors for the grading were Messrs. Winters, Parsons & Boomer, and the work was done during September, October and November, 1898.

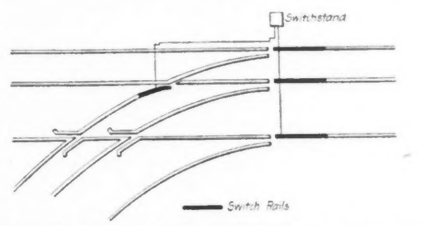
The tracklaying was done by the railway company, but this work was delayed until the spring of 1899, on account of the severity of the winter.

The entire work of grading and tracklaying was completed without delaying traffic, except that all freight and passenger trains were scheduled to run at night.

The new track, which follows the same general alinement and has the same grades as the old, is laid with 8-ft. ties and 60-lb. steel rails, the material being delivered along the track by narrow-gage work trains. By laying towards Trail, the supply point for track material, these trains were able to deliver the material just ahead of the tracklayers in the day time. The system of renewing out of face was adopted, thus allowing joint ties to be properly placed and rails to be full spiked as the new track was being laid. By this method a gang of 40 men would remove 2,500 ft. of old track and replace it with standard track in a day. The greatest record for any one day was 3,800 ft.

Upon the new track a third rail, half spiked, was laid for the narrow gage. Each evening the track so laid was connected to the undisturbed narrow-gage track, over which the narrow-gage trains were run during the night. The operation of narrow-gage trains on one 28-lb. rail and one 60-lb. rail was not attended with any difficulty or accident. To the successful use of the 28-lb. third rail in maintaining the narrow-gage track must be attributed the ease with which the change of gage was executed. Rails were cut for standard gage switches for all spurs, passing sidings and switch-backs, although temporary narrow-gage switches were laid as the work progressed, except in case of Smelter Junction yard, where the tracks were arranged for both gages. Here a combination switch was used, in which a slip point frog was operated by bell cranks attached to the regular switchstand, instead of a double-point rigid frog. This is shown on the accompanying cut.

On June 14 the entire standard gage track was laid except the substitution of standard for the 14 narrow gage switches. On June 15 the Roadmaster, Mr. J. T. Sullivan, divided his 100 track men into six gangs, and the work of changing the switches was started at 7 a. m., after all the narrow-gage equipment was unloaded and taken to Smelter Junction, where it was stored. At 1 p. m. the first passenger train was started from Smelter Junction, arriving at Rossland at 3 p. m. The train consisted of a consolidation locomotive and two passenger cars, rounding successfully the thirty 20° curves, whose aggregate length is nearly three miles. These curves are laid with gage widened 1 in., and with only 1 in. elevation to the outer rail. No guard or check rails are used, and the running rails are laid on Servis tie-



Movable Frog Point in Mixed Gage Track; Rossland Branch, Canadian Pacific Ry.

plates with three spikes in each, which are holding the track to gage without the use of rail braces.

Passenger trains are run up and down this incline at the rate of 12 miles per hour and freight trains at 8 miles per hour.

It may be interesting to note that during the original construction, three years of operation, and the reconstruction of this narrow-gage railway, not a single fatality on account of accident occurred to either passengers or employees. The work of reconstruction, including the widening of gage, was under the direction of Mr. F. P. Gutelius, who had charge of its original construction and was General Superintendent. Mr. Gutelius is now Superintendent of the Rossland Branch of the Canadian Pacific Ry., and we are indebted to him for the information presented in this article.

KITE OBSERVATIONS BY THE U. S. WEATHER BUREAU.

In the annual report for 1897-8 of Mr. Willis L. Moore, Chief of the Weather Bureau of the U. S. Department of Agriculture, there is an excellent summary of the work thus far done with kites as a means of securing aerial pressure, temperature and humidity observations.

The kite finally adopted after many trials is an improved form of the Hargrave cellular type; and while this is satisfactory there is still room for improvement, and the experiments are being continued. The features sought for are power, efficiency, structural strength for given weight and durability; and it is also important that some device be attached that will enable the kite to automatically adjust itself in all winds so as to pull a moderate amount only. One of the points not yet fully worked out is the precise nature of the sheltering effect exerted by the forward upon the rear cell. With these kites there is used a satisfactory reeling apparatus, with a dynamometer, measuring dial and graduated arc, and an improved nephoscope, invented by Prof. Maroni in 1896, for use as an alt-azimuth instrument.

For the automatic register for recording temperature, pressure, humidity and velocity, Prof. Maroni has devised a new form of kite meteorgraph. This instrument weighs 2.1 lbs., and the thermometers are specially constructed to secure an unusually high degree of sensitiveness; they are, in fact, nearly or quite as sensitive as standard mercurial thermometers. As the kite is constantly changing its elevation a sluggish thermograph will not correctly show the temperature at a given spot. Another important feature consists in the exposure of the thermometer bulb and hygrometer. These are placed inside a long tube, 2¼ ins. diameter, open at both ends, and so arranged upon the kite that the wind blows with full speed directly through the tube. It thus gives perfect ventilation of the instruments and screens them from radiation. The tube is wholly inclosed in the instrument case, and insulated from this case, in the heat sense, by plates of ivory and rubber. Accurate results are thus secured.

There are now 16 completely equipped kite stations—at Cairo, Cincinnati, Cleveland, Dodge City, Dubuque, Duluth, Fort Smith, Ark.; Knoxville, Lansing, Memphis, North Platte, Omaha, Pierre, S. Dak.; Sault Ste. Marie, Springfield and Topeka. Washington, D. C., has had a station for some time. The observers are all called to Washington and given a practical course of instruction in flying and managing kites, the whole period of instruction covering about one month.

The standard kite contains about 68 sq. ft. of supporting surface, and only one of these kites is used at one time. Practice has shown the Bureau that one large kite is more satisfactory than several small kites in tandem. Each station was originally supplied with two kites, though a few additional ones have been sent out to replace wrecked kites. The meteorgraph is suspended from the kite, and seems to be completely shielded from injury in ordinary working of the kite. Though some of the kites have been seriously injured no accident is yet recorded for the meteorgraph. In one case, with 12,000 ft. of wire out, the kite was struck by lightning, the wire fused and the kite was set adrift. Both kite and meteorgraph were found next day, 20 miles away; the kite was little injured and the clock in the meteorgraph was still running.

The kite record sheets give the time, length of line, angular elevation and azimuth of the kite, pull in pounds, corrected elevation, surface conditions and conditions at the kite, as to humidity, wind direction, pressure and temperature.

BOOK REVIEWS.

RELATORIO DA ESTRADA DE FERRO DO S. FRANCISCO.—Do Anno de 1897. Apresentado pelo Director, Engenheiro Civil Miguel de Teive e Argollo. Bahia (Brazil), 1898. Paper; 12 x 8 ins.; pp. 178; tables and map and profile.

This is an exceedingly detailed report, for 1897, upon the narrow-gage railway commencing at Joazeiro, on the Rio San Francisco, in Northeastern Brazil, and extending 281 miles to Alagoinhas, near the Atlantic Coast, and there connecting with a railway running to Bahia. As our Portugese editor has the grippe, we abstain from going further into the detail of this report.

THE A B C.—Universal Commercial Electric Telegraphic Code, Specially Adapted for the Use of Financiers, Merchants, Shipowners, Brokers, Agents, etc. Multum in parvo. Simplicity and economy palpable; Secrecy absolute. By W Clauson-Thue, F. R. G. S. Fourth edition. New York: The American Code Publishing Co., 83 Nassau St. 1899. Cloth; 8½ x 5½ ins.; pp. 480. $5.00.

This code has proven its usefulness by the demand for it; and this demand has been met by a reduction in the price from $7.50 to $5.00 in the present edition. The scheme includes code numbers up to 25,400, the code word, and the corresponding phrase or sentence expressed

WEATHER TABLE FOR JUNE, 1899. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.)				Wind. Velocity in miles per hour.		Wind. Direction at time of max. velocity.	Precipitation—Rain or melted snow. (Inches.)		
		Average.	Max.	Min.	Range.	Average.	Max.		Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	63.2	90	35	55	9.0	35	N	1.60	0.48	12
	Portland, Me.	64.5	93	48	45	7.4	24	NW	1.04	0.24	8
	New York City	72 2	97	55	42	11.4	66	NW	1.83	0.71	8
	Pittsburg, Pa.	72.2	93	47	46	4 8	24	SW	3.72	1.02	11
	Chicago, Ill.	69.9	90	49	41	16.1	48	NE	2.71	0.67	8
	Omaha, Neb.	72.1	96	56	40	8.7	36	SW	5.77	2.06	10
	St. Paul, Minn.	67.4	86	48	38	7.6	48	NW	7.23	2.54	13
	Duluth, Minn.	58 1	82	39	43	9.9	36	NE	7.10	3.15	18
	Bismarck, N. Dak.	63.6	91	43	48	9.8	52	NW	5.57	2.75	10
	Average	67.0	91	47	44	9.4	41	—	4.06	1.51	11
Southern Cities.	Washington, D. C.	74 3	97	53	44	5.9	30	SW	2.46	0.81	7
	Louisville, Ky.	76.9	96	56	40	7.3	47	W	3 80	0 86	10
	St Louis, Mo.	77.4	94	58	36	8.9	33	W	2.32	0.75	9
	Savannah, Ga.	80.4	99	58	41	8.4	30	NW	1.07	0.48	7
	Kansas City, Mo.	74 4	92	58	34	9.6	30	S	3.16	1 07	12
	Jacksonville, Fla.	80.1	97	60	37	6.8	30	SW	4.52	2.18	7
	Chattanooga, Tenn.	77.9	96	55	41	5.7	38	NW	2.40	1.80	8
	New Orleans, La.	79 8	94	68	26	7.4	29	SE	7.80	3.68	13
	Memphis, Tenn.	79.0	94	62	32	6.5	36	SW	2.66	1.37	6
	Palestine, Tex.	79 0	94	61	33	7.4	26	S	8.66	4.04	11
	Average	77.9	95	59	36	7.4	33	—	3.88	1.70	9
Western Cities.	Helena, Mont.	58.0	87	34	53	9.4	35	SW	0.84	0.35	10
	Port Crescent, Wash.	50.5	70	35	35	6.0	24	W	0.67	0.31	7
	San Francisco, Cal.	56 9	75	47	28	14.2	44	W	0.01	0.01	1
	Salt Lake City, Utah.	65.2	96	34	62	6.5	41	N	0.96	0.63	4
	Santa Fe, N. Mex.	64.0	84	35	49	7.3	34	SW	1.20	0.38	12
	Denver, Colo.	66.8	96	40	56	8.2	38	S	0.47	0.40	4
	Yuma, Ariz.	—	—	—	—	—	—	—	—	—	—
	Average	60.2	85	38	47	8.6	36	—	0.69	0.35	6

by that code word. The numbers and words run consecutively and alphabetically, and an extended vocabulary index gives the page on which to look up appropriate sentences. Full directions are given for secret telegraphy in cipher.

THE COMMERCIAL AND BUSINESS ASPECTS OF MUNICIPAL ELECTRICITY SUPPLY. — A Practical Handbook for the Use of Electrical Engineers to Municipal Corporations and Members of Municipal Electricity Committees. By Alfred H. Gibbings, M. Inst. E. E., Electrical Engineer to the City of Bradford, Etc., Etc. Bradford, England: Published by the Author. Half leather; 8 x 10 ins.; pp. 270, 57 illustrations and 29 tables. 15 shillings in England; $6 in the United States.

While this book was written specifically for those connected with works owned by municipalities, and almost wholly from the English standpoint, it contains much valuable information for electric supply officials regardless of ownership or country. Among the subjects treated are the organization and management of electricity works; methods of charging for current supplied for various purposes; free house wiring and lamps, and the leasing of motors and arc lamps; prepayment meters; and various uses to which electricity may be put to extend the service, besides lighting and ordinary motor driving. A number of forms of contracts or agreements and bookkeeping systems are given, as well as many useful tables. The halftones and line illustrations are generally good, as is the make-up of the volume. Had a little smaller type, narrower margins, smaller pages and lighter paper been used the book would be more convenient for reference, and could then have been sold at a lower price.

LECONS SUR L'ELECTRICITE.—Par Eric Gerard, Directeur L'Institut Electrotechnique Montefiore. Gauthiere-Villars et Fils, Paris. Paper; 6½ x 10 ins.; pp. 819; 388 illustrations; 12 fr.

This is the first volume of the sixth and latest edition of this well-known French text-book, and it deals with the general theories of electricity and magnetism, electrometry, and the theory and construction of electric generators and transformers. The second volume will treat of the transmission and distribution of electric energy and its application to the telegraph, telephone, traction, lighting, metallurgical operations and power purposes generally. The text of the first volume, now before us, has been revised and added to materially as compared with that of the previous editions. A general idea of the scope of the work may be had from the following summary of the different sections into which it is divided: Chapters I. to X., inclusive, contain general definitions and the theories and laws of electric and magnetic forces, the properties of magnetized bodies, etc. Chapters XI. to XIX., inclusive, discuss electro-magnetism, electro-magnetic induction and the general theory of the propagation of currents. Chapters XX. to XXVIII., inclusive, define and discuss electric measures and measurements. Chapters XXIX. to XXXI., inclusive, treat of thermo-electric couples. Chapters XXXII. to XXXIV. treat of hydro-electric piles. Chapters XXXV. to XL., inclusive, give the theory, design, testing and construction of dynamos, and the remaining four chapters cover the same features for transformers. The volume has an adequate index and is well printed and illustrated.

THE PURIFICATION OF SEWAGE.—Being a Brief Account of the Scientific Principles of Sewage Purification and Their Practical Application. By Sidney Barwise, M. D., Fellow of the Sanitary Institute and Medical Officer of Health to the Derbyshire County Council. New York: D. Van Nostrand Co. Cloth; 5 x 7 ins.; pp. 150; 14 illustrations in the text. $2.

This volume is very properly characterized by its subtitle, to which it may be added that the account is quite satisfactory, considering its brevity. The book gives a very good general idea of the status of sewage purification in England. It also presents a number of valuable suggestions drawn from the author's observations of the plants coming under his jurisdiction as County Health Officer. The limitations of chemical precipitation are presented with fairness. The author does not hesitate to show that the many patented chemical precipitants so widely exploited in England are only combinations in varying proportions, of well-known and commonly-used chemicals, such as lime, sulphate of alumina and copperas. Sometimes one or more of these will be mixed with blood or herring-brine, for the benefit of those who give more weight to the promoter's claims of the marvelous than to the testimony of impartial engineers and chemists.

The author is to be congratulated for being almost the only English writer on sewage purification who credits the Massachusetts State Board of Health with having carried its work at the Lawrence Experiment Station beyond 1890, but even he conveys the idea that the experiments stopped years ago, for he speaks of the board as having "had an experimental station at Lawrence from 1889 to 1893."

The book will be chiefly useful to those taking up the general subject for the first time, or who have not kept themselves posted regarding recent English progress in this field. In addition, there are some good things, not to be found elsewhere, in the way of details of actual practice.

L'INDUSTRIE DU GOUDRON DE HOUILLE.—Par George F. Jaubert, Docteur des Sciences, Ancien Preparateur de Chimie a l'Ecole Polytechnique. Paris: Gauthier-Villars. Paper; 7½ x 7¾ ins.; pp. 172; paper, 2.50 francs; boards, 3 francs.

Coal tar, as an artificial product, dates back to 1681, when John Joachim Becher and Henry Serle took out an English patent for "a new way of making pitch and tarre out of pit coale, before never found out or used by any other." But the first important application of coal tar was made by Bethell, in 1828, who obtained a patent in England for preserving wooden crossties for railways by impregnating them with the heavy oils obtained from gas-tar. From this period the distillation of coal tar became a recognized industry. The presence of benzine in coal tar was discovered by A. W. Hofman in 1845; Mansfield in 1847, made known for the first time the exact composition of coal, and in 1856 William Henry Perkins discovered mauveine, the first of the artificial coloring compounds found in coal tar.

The author then takes up the extraction of coal tar in the manufacture of illuminating gas, and in making coke, and giving a long table showing the amount obtained from different coals, the average volume being represented by about 5% of the total coal. The peculiar properties of coal tar are treated in the second chapter, where this product is generally described as an extremely complicated mixture of chemical combinations which have not yet been altogether isolated. A series of tables by Lunge enumerates the separate constituents which have been found in coal tar, up to the present time, or those whose presence is indicated in an undoubted manner. These tables show 72 named hydrocarbons; 15 phenol compounds, including wood and ethylic alcohol, acids, etc.; 11 sulphur compounds; and 21 nitrogen compounds; or 119 in all, which are here separately described and credit given to their discoverers. Succeeding chapters treat of the distillation of coal tar by various methods, and the extraction of heavy oil and spirits of naphtha, the preparation of phenic acid and phenol, naphthaline, etc. The distillation of pitch for obtaining more anthracene or green oil—the most precious element in coal tar, and the further utilization of this pitch in making fuel briquettes, forms the concluding chapter.

ELECTRICITY IN TOWN AND COUNTRY HOUSES.—By Percy E. Scrutton. 2d edition; 1898. Westminster: Archibald Constable & Co. 5 x 7½ ins.; cloth; pp. 148; illustrated; price, $1.00.

There was a time a score of years or so ago in this country when some very trashy books were written and published and accepted by the general public as treatises on electricity. This book may safely be classed under this heading.

The author begins his preface with the statement that:

The object of this book is to put before the reader, in a popular form, the many uses to which electricity can be put in his house to serve his comfort and convenience and the cost which the use of it entails.

Thirty-three pages follow, in which the advantages of electricity are somewhat vaguely set forth. This is followed by 37 pages and several full-page illustrations describing the production of electricity in city central lighting stations. In this the storage battery plant of the Lane substation, in Glasgow, is illustrated and very briefly described, and the Dust Destructor plant of the Shoreditch Vestry, London, is illustrated, all of which has nothing to do with electricity in houses.

Chapter III. considers the production of electricity by an independent plant, or, as we say, isolated plant; but the owner of a country house who should take it as a guide would be apt to get into serious trouble.

The next chapter on distribution within houses is in reality a continuation of the first chapter on advantages of electricity, and consists of a rather rambling text, interrupted frequently by good and bad illustrations, ranging from elaborate electroliers to electric frying-pans.

The last chapter on cost of electricity is the best in the book, but relates largely to English practice.

NEW TRANSATLANTIC STEAMERS will be in service on several lines for the heavy traffic in connection with the Paris exhibition next year. The White Star Line will have the "Oceanic," 704 ft. long, 68 ft. beam, 49 ft. deep, 32 ft. 6 ins. draft, with a displacement of 28,500 tons and a speed of 20 miles per hour. The Transatlantic (French) Line will have two new boats, "La Savoie" and "La Lorraine." The North German Lloyd Line will have the "Kaiserin Maria Theresa" and the "Grosser Kurfurst." The former will be the old steamer "Spree," lengthened and fitted with new engines. It will be 546 ft. long, 52 ft. beam, and 37 ft. deep, with a loaded displacement of 13,600 tons. The Hamburg-American Line will have the "Columbia," repurchased from the Spanish government, and the new steamer "Deutschland." The latter will be 686 ft. 6 ins., long, 67 ft. 4 ins. beam, and 44 ft. deep, with a sea speed of 23 knots.

A SEPTIC TANK SYSTEM was put in operation at Barrhead, Scotland, on June 15. According to the London "Contract Journal," it is designed to serve a population of 10,000 and to treat a maximum flow of 480,000 U. S. gallons of sewage and storm water. The sewage passes, unscreened, through two grit chambers to four septic tanks, each 18 x 100 ft., x 7 to 8½ ft. deep. The normal depth of 7 ft. gives a total tank capacity of about 375,000 U. S. gallons and the maximum depth, 460,000 gallons, the variation being designed to accommodate storm water. The tanks are covered with concrete and steel arches, resting on brick piers. From the tanks the sewage passes through slotted pipes to an effluent chamber, and thence through flow-regulators and aerators to two outlet chambers, each supplying sewage to four filter beds. The admission of sewage to the filter beds, and the discharge of sewage from them, is automatically performed by means of the overflow of a small quantity of effluent. Each of the eight filter beds is 54 x 55 ft., giving a total area of a little over a half acre. The filtering material is 4 ft. of broken furnace clinker. Ordinarily only six filters are used, two being kept in reserve. Five tanks are idle, or resting, while the sixth receives the effluent from the septic tank, which is discharged on the surface by means of stoneware channels. The effluent remains in the bed about 90 minutes when the discharge valve opens and air takes the place of the sewage. The system is controlled by the Septic Tank (Foreign and Colonial) Syndicate, Exeter, England, of which Cameron, Commin & Martin are Managing Directors and Engineers.

ALUMINUM FEEDERS are to be used on the new Northwestern Elevated Ry., of Chicago, and contracts have been let for 150,000 lbs. of this feeder cable, the diameter varying from 1 to 1½ ins. The insulators are merely burnt-shale grooved supports, carried in a box which forms the footwalk along the structure. The details of the insulating supports are similar to those of the Lake St. and Union Loop elevated lines in the same city, both of which, however, use bare copper feeders. Mr. James R. Chapman is manager of the Electrical Department of the Northwestern Elevated Ry.