ENGINEERING NEWS AND AMERICAN RAILWAY JOURNAL.

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A BRIDGE RENEWAL of some interest was successfully accomplished by the Pennsylvania R. R. at Newark, N. J., July 23, when the old draw span over the Passaic River, near the Market St. station, was removed, and a new structure put in its place. The span is 213 ft. long, and the old bridge was built in 1868. The rest pier, or guard pier, was extended 250 ft., in each direction, and the Edge Moor Bridge Works, of Edge Moor, Del., built the new 500-ton structure on the downstream extension, supporting it on eight car trucks running on rails laid the whole length of the pier. Car trucks were placed to receive the old span, and at 10:30 a. m., July 23, the old span was opened for the last time; jacked up, and deposited on the trucks. The old and new spans were then lashed together end to end. The hauling was done by 6-in. hawsers rove sixteen-fold from the upstream end of the old bridge to two hoisting engines on the end of the pier. At 12.58 p. m., the hauling was commenced, and in 8 minutes the new bridge was in position, but 10½ minutes more were occupied in adjusting it exactly upon its center. In an hour the bridge was lowered into place, and the gearing was fitted. The old bridge will be broken up. The new bridge was designed by Mr. Wm. A. Pratt, Engineer of Bridges, Pennsylvania R. R., and Mr. S. P. Mitchell, Manager, Edge Moor Bridge Works, designed the method by which the old structure was removed and the new bridge put in its place. The work of removal was carried out under his direction and that of Mr. H. F. Lofland, Engineer of Erection, Edge Moor Bridge Works. Mr. W. B. Fortune was the foreman in charge.

THE NIAGARA SUSPENSION BRIDGE, connecting Lewiston, N. Y., with Queenston, Ont., was opened July 21, with some ceremony. The cable span from tower to tower is 1,040 ft. (the same as the old bridge), and the stiffening truss is 800 ft. long. The width of the roadway is 25 ft. The towers are of stone; those on the American side are 28 ft. back from the edge of the bluff; their bases are 13 ft. square, with a height of 26 ft. The towers on the Canadian side are 15 ft. from the edge of the bluff, with a base 12 ft. square. There are four cables, each composed of 14 2¼-in. galvanized cast steel wire ropes. The anchorages are drilled into the solid rock and heavily cemented. The total weight of the bridge is about 1,000 tons. The first suspension bridge to span the gorge at Niagara Falls, which the present structure has replaced, was erected in 1850. The floor of this structure was blown away in 1864. The bridge is owned by the Lewiston Connecting Bridge Co., of New York State, and the Queenston Heights Bridge Co., of Canada, embraced in the International Traction Co. The consulting engineer was L. L. Buck, M. Am. Soc. C. E., and the constructing engineer R. S. Buck, M. Am. Soc. C. E. The bridge was described and illustrated in our issue of Jan. 12, 1899.

THE CANADIAN NIAGARA POWER COMPANY'S privileges have been extended. In March last the Parliament of the Province of Ontario, Canada, authorized a new agreement to be made between the commissioners of the Queen Victoria Niagara Falls Free Park, representing the government of Ontario, and the Canadian Niagara Power Co., which is practically the Niagara Falls Power Co., about the same capital being interested. This agreement was signed on July 15, and its provisions make several notable changes in the proposed power development on the Canadian side at Niagara. By it the time in which the Canadian Niagara Power Co. must have 10,000 developed horse-power is extended to July 1, 1903. The new franchise is for 110 years, and the rent has been reduced from $25,000 to $15,000 per annum. There are also other amendments in regard to the location of the plant, power-house, etc., the plans for all which have now been approved. In consideration of this more advantageous agreement the Canadian Niagara Power Co. on its part has yielded its exclusive right to the use of the waters within the Canadian Park, and the commissioners of the park are now at liberty to deal with other companies for the development of power outside the territory occupied by the Canadian Niagara Power Co. This company has now a small amount of power developed by a temporary installation placed in the power house of the Niagara Falls Park & River Ry.

THE THREATENED FIGHT AGAINST THE CHICAGO Drainage Canal has been started at St. Louis by the adoption of a resolution by the municipal assembly instructing the city counselor to take legal steps "to enforce the rights and protect the interests of St. Louis." It is stated that application for an injunction against the use of the canal will be made to the Federal Court in Illinois at an early day. In view of the possibility that there may result from this action one of the most famous legal battles in the history of sanitation, we give the resolution in full as follows:

Whereas, The city of Chicago has constructed a channel and proposes to use it as an outlet by which the sewage of the entire city of Chicago for all time to come is to be discharged into the valley of the Desplaines River, and whence, through the Illinois River, the polluted waters will reach the Mississippi River, about forty-five miles above St. Louis;

Whereas, It is proposed to discharge the sewage of Chicago through this channel without any attempt at purification other than the very uncertain benefit which may come from certain proportions of dilution;

Whereas, The carrying into effect of the scheme as above outlined must materially affect the interests of St. Louis injuriously, and also perhaps in a greater degree the interests of the neighboring cities, Alton and East St. Louis, by polluting the only source from which water supplies can be taken;

Whereas, Sanitary and medical science has demonstrated that the epidemics and diseases most to be feared are directly produced by the polluted water supplies and waters once polluted, will never by natural processes be made safe for drinking purposes, it must necessarily follow that the pollution of the sources from which St. Louis and its neighboring cities must take their water supply is an irreparable injury which cannot be compensated for and must be prevented; and, therefore, be it

Resolved, That the city counselor is hereby instructed to take such legal steps as may be necessary to enforce the rights and protect the interests of the city of St. Louis.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was due to the fall of a trestle under a mixed train on the Chesapeake & Nashville Ry., a 35-mile line from Gallatin, Tenn., to Scottville. The train was crossing a trestle 60 ft. high between Bledsoe and Westmoreland, and the locomotive had just reached the bank, when the structure collapsed. The engine, with three passenger cars and three freight cars, went down, and the wreck caught fire. Two men were killed and four of the passengers were injured.

A LOCOMOTIVE BOILER EXPLOSION occurred July 16 near Hillsville, Pa., on the Pennsylvania R. R. The engine was switching cars at the time. Three men were badly hurt.

TWO TORPEDO BOAT ACCIDENTS are reported this week. On July 21 one of the connecting rods of the starboard engine of the British torpedo boat "Bulfinch" broke during the trial trip and knocked off a cylinder head. Before steam could be shut off and the engine stopped, nine men were killed and four injured by the flying metal and the scalding steam. The vessel was running at a speed of 30 knots per hour.——On July 23 one of the boilers exploded on the Austrian torpedo boat "Adler," in the Adriatic Sea, killing an officer and five men.

A MINE EXPLOSION occurred July 24 in the mine of the Redstone Coal, Oil & Gas Co. at Grindstone, Pa. Three men were killed and three injured.

THE ELECTRICAL EXHIBITION at Como, Italy, was destroyed by fire on July 10, and the embroidery exhibition of industrial art and silk industries were also destroyed. Many valuable historical relics of Volta, his books and instruments, were burned.

THE STREET RAILWAY STRIKE in Brooklyn, N. Y., was commenced July 16, and has caused considerable inconvenience to the public, more particularly to persons wishing to visit the various suburban and seaside resorts reached by the electric cars. Cars have been run on most of the city lines, but the service was for some days practically stopped on the suburban lines. Some little rioting, with blockading of tracks and stoning of cars, has been experienced, but the police, aided by re-enforcements from New York, have been able to deal with the violent element among the strikers and their sympathizers. Various grievances are alleged, but they seem to have settled down to a claim that the ten-hour law must be strictly observed by the street railways. A short sympathetic strike was started on the Second Ave. line in New York, but did not last long. The most serious attempt at violence in Brooklyn was the damage done to two columns of the Brooklyn Elevated R. R. by dynamite exploded within them.——Dynamite has also been used by the street railway strikers at Cleveland, O. A bomb thrown into the car barn damaged one of the cars, and dynamite placed on the tracks blew up a car, injuring four passengers.

A LIGHTHOUSE has been established in the St. Lawrence River at Travers, Que., to take the place of a lightship which had to be removed before the end of every season of navigation, and could not be put in place again in the spring until some time after the river had been open for navigation. The absence of the light was a danger to the ocean steamers. The foundation is a timber crib which was sunk in 45 ft. of water and anchored by having stone filled into and around it.

A BREAK IN THE HENNEPIN CANAL, in Bureau county, Ill., has been caused by shifting quicksands. The steam shovels excavating the canal cut through a bed of hardpan overlying the quicksand, and the surface water all drained through into the sand, and caused it to slide and settle, so that the bottom of the cut is now 10 ft. below the established grade. Reports state that no firm bottom can be found at a depth of 40 ft.

A STONE DRY-DOCK at the League Island Navy Yard, Philadelphia, Pa., is now proposed, instead of the wooden dock, bids for the construction of which will be opened Aug. 5. The cost of the timber dock is estimated at $825,000, and that of the stone dock at $1,100,000. It is said that there will be a reservation in the contract to be made Aug. 5, providing that if hereafter Congress shall authorize the construction of a stone dry-dock instead of a wooden one, the contractor must construct the dry-dock of stone accordingly. The increased expense of the stone construction will be fixed at its cost value by a board of naval officers, and a profit of 10% thereon will be allowed the original contractors.

A NEW RAILWAY IN FORMOSA is to be built by Japan, and the sum of $1,000,000 has been appropriated for this year. Work will be at once commenced at Takow on the Takow-Tainan branch, a line 28 miles in length. The land is quite level, and the work presents no difficulties, except the bridging of two small rivers. Trains will be running over this Takow branch in two years. The present northern line runs from the Tamsui River in a southerly direction 40 miles to Hsinchiku (Teckcham). It was built by the Chinese and completed in 1893. From the Tamsui River to Twatutia, the foreign settlement, the line runs over nearly level ground for some 7 miles. It then ascends a table-land, on a maximum grade of 3%, and for the rest of the distance, with the exception of a few miles outside of Hsinchiku, it zigzags through the hills on the side of a valley. It has always been unsatisfactory, and portions of the line have been frequently destroyed by storms and freshets. Formerly, a bridge across the Tamsui River permitted the trains to run into Twatutia; but this, as well as several bridges a few miles from Hsinchiku, were destroyed during last year's great typhoon, one large iron bridge being carried 260 ft. by the force of the wind and current. At present, therefore, the line does not touch either of the original terminals. The Japanese find that this line must be almost entirely rebuilt. A new bridge nearly 2,000 ft. in length and costing some $400,000, will be constructed across the Tamsui River at Twatutia, and the route will follow in a general way the original road, though while passing through the hills it will be on the opposite side of the valley, and by the aid of two tunnels and many cuttings it will be much straighter than the old line. The bridge will be commenced this year, and the line probably finished in two years. From Hsinchiku (Teckcham) to Tainan is 145 miles, and it is the intention to build the railway between these two points as soon as the work mentioned above is completed. This line will require numerous and expensive bridges and some 13 tunnels. When completed it will give a railway service from Keiung to Takow, a distance of 205 miles. Mr. Hasegawa is the Chief Engineer. The Chief of the Communication Department states that in all probability the locomotives, rails, and bridge material will be obtained from the United States, and that the order will, he believes, go to the Carnegie Steel Co. The gage of the present line is 3 ft. 6 ins., the rails 36 lbs. per yd., and the ten locomotives used are of English and German manufacture. The new locomotives will be heavier than the ones at present employed, and the rails will weigh 60 lbs. per yd.

THE TOILET CONVENIENCES IN A MODEL FOUNDRY.

We commend the two views here shown to the thoughtful consideration of every proprietor or manager of a manufacturing establishment. They show the washroom and bathroom for the use of employees in the new foundry of the Walker & Pratt Mfg. Co., of Boston, manufacturers of stoves and ranges. This new building and its equipment was fully described by Mr. A. W. Walker, of the above firm, in a paper read at the last meeting of the American Foundrymen's Association, and we risk little in saying that it has been planned from start to finish with a care and intelligence such as is bestowed on few manufacturing plants.

Throughout this establishment the care for the comfort of the employees is a noticeable feature. The managers believe that this course is dictated by sound business considerations, to say nothing of humanity. They have found that workmen in a comfortable well-lighted building will do more and better work, and that a better class of workmen can be secured by a factory run with consideration for the men's comfort and welfare.

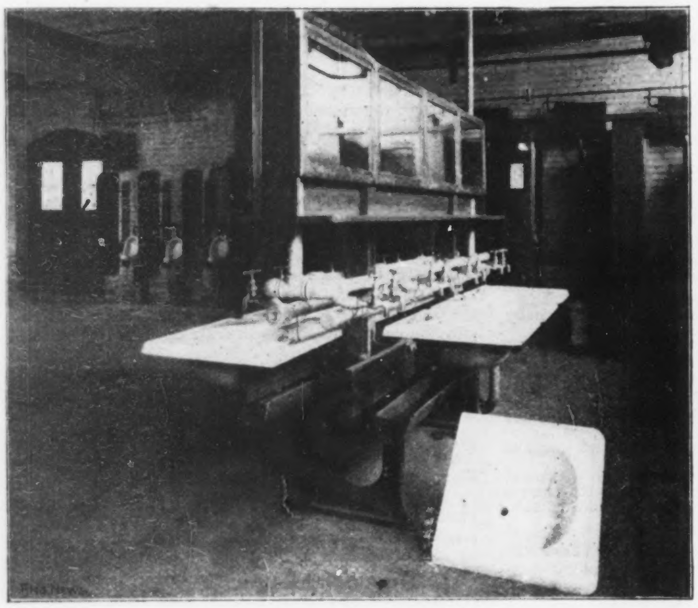
Foundry work is necessarily productive of dirt; but soap and water can remove it; and it will be seen from the accompanying views that a workman in the Walker & Pratt establishment can go home from his day's labor in self-respecting cleanliness. The sanitary appliances, moreover, have been so designed that they are at once convenient for those who use them, easily kept clean, and require a minimum of repairs to keep them in order. A primary idea in the design was to dispense as far as possible with the services of the plumber, and for this reason a novel plan for disposing of the waste water has been adopted.

Fig. 1 shows a part of the washroom, with the closets and urinals. It will be seen that the regular "set bowl" of the plumber, with its wiped joints on outlet and overflow, is dispensed with entirely. Two substantial cast-iron standards have a plain rectangular slab or iron bolted to them on each side, while central posts support a wooden frame which carries mirrors and a shelf for other toilet necessaries. The wash-bowls are of cast iron, made in the works, and covered with white enamel. Lugs on the underside slip over the longitudinal bar and support the bowl without other fastening. A trough of sheet copper beneath receives the discharge from the bowls and carries it to the outlet at one end, where it falls into a covered gutter in the concrete floor. Thus the whole apparatus is open to inspection and cleaning. Over each bowl is a hot and cold water faucet attached directly to the iron pipe system, so that no plumbing work was required even here. The water pipe system, moreover, is entirely independent of the frame which supports the bowls, so that there is no chance of strains and leaks on the pipe from any movement of the latter. We may add that soap powder canisters are secured to each bowl, a wrinkle of neatness which anyone who has seen a cake of soap in a factory washroom will appreciate.

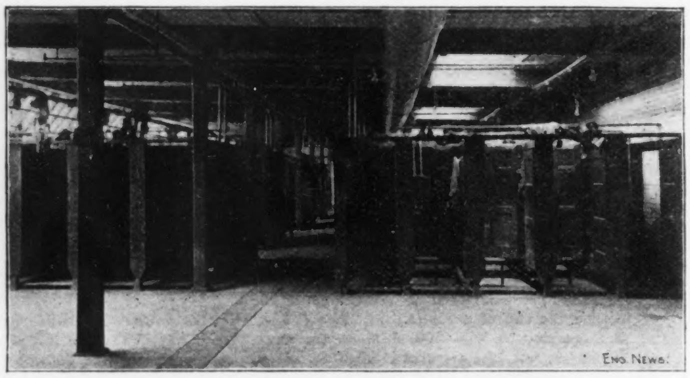
Fig. 2 shows the bathrooms, and it will probably strike some people with surprise to learn that every molder in the works has his private bathroom. The entire floor of the bathroom is covered with concrete; and movable wooden gratings on which the occupants stand are in every room. The water drains to the covered central gutter. As may be seen in the cut, each bathroom contains hot and cold water faucets, a seat, a pail, hooks for clothing, etc., and an inner closet with a Yale lock where the occupant can leave his ordinary clothing and valuables in security. Incandescent lamps overhead furnish light, and the steam pipes keep the room comfortably warmed.

One man has charge of both bath and washrooms, keeps everything neat and in order and has considerable time left for odd jobs in other parts of the works.

We are indebted to the courtesy of Mr. A. W. Walker, Secretary of the Walker & Pratt Co., for the photographs from which our illustrations are reproduced.



VIEW IN THE WASHROOM.



VIEW OF THE BATHROOM.

THE TOILET CONVENIENCES IN A MODEL FOUNDRY.
The Walker & Pratt Mfg. Co., Boston, Mass.

HEAVY FREIGHT LOCOMOTIVES FOR THE LEHIGH VALLEY R. R.

(With two-page plate.)

The economy in transportation expenses which may be realized by increasing the freight train loads is now pretty generally recognized, and the Lehigh Valley R. R. has recently decided to put in service locomotives which will haul twice the load of the present engines. These specially large and powerful engines, which were noted in our issue of March 23, are of the consolidation type, and are intended for the Buffalo Division, between Sayre, Pa., and Buffalo, N. Y., 180 miles. The maximum grade is 21.2 ft. per mile for a distance of 37 miles, and the engines are to haul train loads of 2,000 tons (behind the tender) at speeds of 20 to 30 miles per hour. They will replace ten-wheel engines, with cylinders 20 × 24 ins., which now haul train loads of about 1,000 tons.

The engines were designed by Mr. Samuel Higgins, Superintendent of Motive Power of the Lehigh Valley R. R., and we are indebted to him and to Mr. F. F. Gaines, Mechanical Engineer of the road, for drawings and particulars. Two of these engines have just been completed by the Baldwin Locomotive Works, of Philadelphia, Pa., and if these prove satisfactory in service about 20 more will be ordered. One of the two engines will be a simple engine, with cylinders 21 × 30 ins., the other will be a Vauclain four-cylinder compound, with cylinders 17 × 30 and 28 × 30 ins. In all other respects but the compounding the engines will be identical.

A somewhat notable feature of the design is the use of driving wheels of unusual diameter for this type of engine. These wheels are 62 ins. diameter, as against 56 ins. on the largest consolidation engines and 68 ins. on the largest ten-wheel freight engines at present in use on this road. The ordinary size of drivers for consolidation engines is 50 to 56 ins., and the largest engine in the world is a consolidation engine with 54-in. driving wheels (Eng. News, Oct. 27, 1898). The engines which rank next to the Lehigh Valley engines in this respect, however, are the consolida-

Dimensions of Recent Large Consolidation Locomotives.

	Union Railway.	Lehigh Valley R. R.	Pennsylvania R. R.	Norfolk & Western R. R.	Ottawa, A. P. & Pac. Ry.	Burl. & Mo. River R.R.	Lehigh Valley R. R.	Baltimore & Ohio R. R.	Southern Ry.
Builder	Pittsbrg L.W.	Baldwin L.W.	Altoona Shps.	Baldwin L.W.	Baldwin L.W.	Pittsbrg L.W.	Baldwin L.W.	Baldwin L.W.	Richm'd L.W.
Driving wheels	54 ins.	55 ins.	56 ins.	56 ins.	56 ins.	52 ins.	62 ins.	54 ins.	58 ins.
Wheelbase, driving	15 ft. 7 ins.	15 ft. 0 ins.	17 ft. 6 ins.	15 ft. 6 ins.	15 ft. 1 in.	15 ft. 0 ins.	16 ft. 3 ins.	15 ft. 4 ins.	15 ft. 6 ins.
Wheelbase, total	24 " 0 "	23 "10 "	25 "11½"	24 " 6 "	23 " 9 ins.	23 " 6 "	25 " 5 "	23 " 8 "	23 " 8½"
Weight on drivers	208,000 lbs.	202,232 lbs.	177,000 lbs.	166,000 lbs.	165,000 lbs.	166,000 lbs.	155,000 lbs.	156,000 lbs.	134,000 lbs.
Weight, total	230,000 "	225,082 "	198,000 "	186,000 "	184,500 "	181,000 "	175,000 "	172,000 "	152,000 "
Cylinders, number	2	4	2	2	4	2	2*	2	2
Cylinders, size	23 × 32 ins.	18 & 30 × 30"	23½ × 28 ins.	23 & 35 × 32"	15½ & 26 × 30"	22 × 28 ins.	21 × 30 ins.	22 × 28 ins.	21 × 28 ins.
Boiler, diameter	6 ft. 8 ins.	6 ft. 8 ins.	6 ft.	5 ft. 8 ins.	5 ft. 8 ins.	6 ft. 2 ins.	5 ft. 5 ins.	5 ft. 4 ins.	5 ft.
Working pressure.	200 lbs.	200 lbs.	185 lbs.	200 lbs.	180 lbs.	180 lbs.	200 lbs.	180 lbs.	200 lbs.
Firebox	120 × 40 ins.	120 × 108 ins.	120 × 40 ins.	121 × 42 ins.	120 × 42 ins.	114¾ × 40 ins.	114¾ × 96 ins.	118 × 41 ins.	102¾ × 42 ins.
Tubes, number	355	511	369	306	321	292	358	246	271
Tubes, length	15 ft.	14 ft. 7¾ ins.	14 ft.	14 ft. 6 ins.	13 ft. 6 ins.	14 ft. 6 ins.	15 ft. 1 in.	14 ft. 10½ ins.	14 ft. 4 ins.
Heating surface of tubes	3,117 sq. ft.	3,891 sq. ft.	2,720 sq. ft.	2,594 sq. ft.	2,253 sq. ft.	2,486 sq. ft.	2,810 sq. ft.	2,143 sq. ft.	2,008 sq. ft.
Heating surface, total	3,322 "	4,106 "	2,917 "	2,789 "	2,455 "	2,675 "	2,987 "	2,321 "	2,164 "
Grate area	33.5 "	90 "	33.5 "	35 "	35 "	31.5 "	76.3 "	33.6 "	30 "
Date in Engineering News	Oct. 27, 1898.	Nov. 24, 1898.	....	....	....	Sept. 1, 1898.	Present issue.	....	May 5, 1898.

*A similar engine, but compound, has four cylinders, 17 × 30 and 28 × 30 ins.

tion engines of the Southern Ry. (Eng. News, May 5, 1898), which have 58-in. driving wheels. The driving wheel base is 16 ft. 3 ins., which is 8 to 15 ins. more than usual, and all the wheels have flanged tires. To facilitate the passage of curves, therefore, the leading and trailing pairs have a wheel gage (or distance back to back of flanges) of 53 ins., or ¼-in. less than that of the others, which have the normal wheel gage of 53¼ ins. This driving wheelbase is exceeded, however, in the Class H-5 consolidation engines of the Pennsylvania R. R., whose wheelbase is 17 ft. 6 ins. For the purposes of comparison, we give herewith the leading dimensions of some modern heavy consolidation engines.

The spring rigging of the Lehigh Valley engines also calls for attention. A yoke over each truck axle-box carries two helical springs, and the truck equalizer is connected to the front hangers of the leading driver springs. The first and second driving axles have the springs over the boxes connected by short equalizers, and the rear hangers of the second set of springs are attached directly to the frames. The two rear axles have yokes over the boxes, with hangers connected to three inverted plate springs. The first of these is connected to one of the pedestals, and the third to a suspension hanger, both of these springs being seated under the frame.

In the compound engine the low-pressure cylinder (which is the upper one) will be swung inward, so as to keep within the clearance limits. This of course throws the high-pressure cylinder outward, so that the centers of the cylinders are 2 ins. apart in a vertical plane, as shown in the cross-section. Four-bar girders with deep vertical bearing surfaces provide for the consequent uneven pressures of the crosshead upon the guides. Hollow piston rods of nickel steel will be used, 3 ins. and 4½ ins. inside and outside diameter respectively.

The boiler is of the straight-top type, and though it looks short (owing to the position of the cab) it will be seen that it really is of exceptional length, having tubes 15 ft. 1 in. long. The firebox is of the Wooten type, for burning anthracite coal, extending beyond the frames. It has two hopper ashpans, separated by the rear driving axle. The injectors, injector piping, feed pipe and sand pipes make a rather unsightly complication. The smokebox is of the short extension type, with cylindrical smokestack, and it will be seen that the exhaust nozzles are set quite low. The sandbox and dome are on the boiler barrel, and the dome is outside of the cab. On the firebox are the bell and the fitting for the safety valves.

The general dimensions of the engine are given below in our standard form, and it will be noted that this is one of the many cases in which the standards of the Master Mechanics' Association are disregarded, neither the counterbalancing nor the smokebox arrangements conforming to these standards:

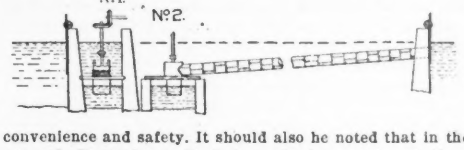
Heavy Consolidation Freight Locomotives;
Lehigh Valley R. R.

Running Gear:	
Driving wheels (8), diameter	5 ft. 2 ins.
Truck wheels (2),.....3 ft.; Tender wheels (8)	3 ft.
Driving wheel centers	Cast steel.
Truck and tender wheels	Steel-tired.
How are driving wheel tires secured?	Shrinkage.
Engine truck	Swing center.
Journals: Truck axles, 6x12 ins.; driving axles	9 × 12 ins.
Wheelbase: Driving	16 ft. 3 "
Total engine	25 " 5 "
Tender ......15 ft. 9 ins.; Engine and tender	52 " 2⅝"
Engine, truck-pin to c. leading driving wheel.	9 " 2 "
Wheels having blind tires.	None.
Weight in Working Order:	
On driving wheels	155,000 lbs.
On truck wheels	20,000 "
Engine, total	175,000 "
Tender, empty, 39,000 lbs.; Loaded	96,500 "
Water in tank	37,500 "
Coal in tender	20,000 "
Does counterbalance conform to M. M. Assoc. rules?.	No; Bald. L. W. and L. V. R. R. standard.
Cylinders (Simple engine): Number	2
Diameter and stroke	21 × 30 ins.
(Compound engine) Number	4
Diameter and stroke	17 × 30 and 28 × 30 ins.
Crosshead and guides.	Cast-steel crosshead; 4-bar guides.
Connecting rods, length between centers	11 ft. 1¼ ins.
Side rods	Solid ends.
Valve Gear: Type	L. V. R. R. standard link-motion.
Ports, steam	1½ × 19 ins.
Eccentrics, throw	2⅝"
Valves, style, piston; diameter	5⅛"
" maximum travel	5¾"
" inside lap....0 ins.; outside lap	⅞-in.
" lead (full forward and backward gear)	1-32-in.
Boiler: Type	Straight top.
Barrel, diameter, inside smallest ring	5 ft. 4⅞ ins.
Dome, diameter	2 " 6 "
Thickness, barrel plates	11-16-in.
Thickness, smokebox tube-plate	⅝-in.
Horizontal seams	Double riveted.
Circumferential seams	Sextuple riveted.
Joints	Butt, double cover plates.
Rivets, diameter	1⅛ ins.
Height from rail to center line	8 ft. 10¾ ins.
Length of smokebox, including extension	5 " 5 "
Does smokebox arrangement conform to M. M. Assoc rules?	No.
Spark arresting device	L. V. R. R.; basket netting.
Injectors (2), kind	Metropolitan No. 10.
Working steam pressure	200 lbs.
Firebox: Type	Wide, above and over frames.
Length inside. 9 ft. 6¾ ins.; width, inside	8 ft.
Depth at front and back	5 ft. 4¼ ins.
Thickness, side plates. 5-16-in.; back plates	⅜-in.
Thickness, crown plate. ⅜-in.; tube plate	½-in.
Crown stays	Radial.
Grate bars	Long shaking.
Is fire-brick arch used?	No.
Stay bolts....Drilled holes, 1-in. deep and ⅛-in. diam.	
" diameter	1 and 1⅛ ins.
" pitch	4 "
Water spaces, width at front	4 "
Water spaces, back and sides	3½"
Tubes: Best charcoal iron; No.	358
Pitch ....2⅝ ins.; Diameter outside	2 ins.
Length over tube plates	15 ft. 1 in.
Heating Surface and Grate Area:	
Heating surface, tubes (exterior area)	2,809.6 sq. ft.
" " firebox	177.7 "
" " total	2,987.3 "
Grate area	76.33 "
Miscellaneous:	
Exhaust nozzle (double) diameter	4⅛ ins.
Exhaust nozzle, distance below c. of boiler	10½ "
Smokestack, diameter top, 19½ ins.; at base	18 "
" height above smokebox	3 ft. 4 "
" height of top above rail	15 ft.
Capacity of tender tank	4,500 gallons.
Cacapity of coal space	20,000 lbs.

ELEMENTS OF DESIGN FAVORABLE TO SPEED REGULATION IN PLANTS DRIVEN BY WATER POWER.*

By Allan V. Garratt.†

The writer has found, in a practice amounting to something over 90,000 HP. of water-wheels in the last four years, that with good water-wheels properly set and rigged, and controlled by governors of suitable design, the speed may be held within 5 or 6% of normal upon circuit breakers opening under full load, and that the speed may be brought back to normal in from 5 to 15 seconds, depending upon the amount of kinetic energy in the rotative parts and moving water column. With incandescent loads of the ordinary type, a recording tachometer will show a practically straight line. With ordinary electric railway loads, speed variations of about 3% as a maximum may be expected. These figures are not intended to be of unusual application, but are for simply showing the present state of the art. It should here be added that governors can be obtained which will permit any number of independent water-wheel units driving electrical units connected in parallel to be operated with perfect



convenience and safety. It should also be noted that in the case of alternating units it is perfectly easy to get them at speed and in step for multiple connection without undue delay, and without any hand regulation.

These desirable ends cannot, however, be obtained to their fullest extent if the general design of the hydraulic portion of the plant is bad. We will now consider those things, aside from the governor itself, which tend to make the regulation good or bad.

As a preliminary thought, let us consider for a moment that the problem is quite different from steam-engine governing, which naturally comes to the mind in this connection, for the reason that water is heavy, practically non-compressible or non-expansive, and must be transmitted to the water-wheel in large volume and at low velocity; while steam is light, highly compressible and expansive, and may be transmitted to the engine in small volume and at high velocity. From this it follows that the engine valves are small, light, and may be perfectly balanced, while water-wheel gates are necessarily large, heavy, and are frequently, although often unnecessarily, out of balance. The inertia of the steam may be always neglected; the inertia of the water must be always considered.

The problem of governing a water-wheel, then, involves moving large volumes of a heavy practically incompressible fluid acted on by the force of gravity alone, and of moving ponderous gates; and this must be done with absolute promptness. Also adequate provision must be made for the momentum and inertia of the moving water and mechanical parts.

Suppose we have two water-wheels operating under the same head, which we will assume to be 9 ft. You will observe that although the head is the same in both cases, one wheel, which we will designate No. 1, is set in an open flume of ample size; while the other wheel, which we will designate as No. 2, is in a closed flume connected to open water by a long closed pipe which is nearly horizontal. The behavior of these two wheels when operating under variable load, is entirely different.

Let us assume, for the purposes of argument, that the efficiency of the wheel is the same at all stages of gate, and that the amount of water which passes through the wheel is proportional to the gate opening, and that the power of the wheel is proportional to the amount of water which passes through it under constant pressure. Now, if the wheel is operating at full gate and half the load is suddenly thrown off, and the suitably designed governor attached to the wheel promptly shuts the gates so that only one-half as much water can pass as when the wheel was at full gate, it is evident that the speed will remain comparatively constant.

Let us see if this will be the case with wheel No. 2. If it is operating at full load, and half the load is instantly thrown off, and the governor promptly shuts the gates so that only half as much water can pass, it is evident that the velocity of the water in the closed pipe must be reduced one-half.

If we assume that the water in the pipe weighs 1,000,000 lbs. and has a velocity at full head of 4 ft. per second, its energy = 1,000,000 ÷ 32.2 × 4² ÷ 2 = 248,440 ft. lbs.; and if the water velocity at half load is 2 ft. lbs., per second, then the energy = 1,000,000 ÷ 32.2 × 2² ÷ 2 = 62,110 ft. lbs., and the difference between these two amounts of energy, 248,440 — 62,110 = 186,330 ft. lbs., must be expended upon the water-wheel before the water velocity is reduced to 2 ft. per second.

If it were expended in one second it would = 186,330 ÷ 550 HP., but this is a little quicker than we would expect to do in practice. Suppose we slow up the water column in two seconds, then the energy expended = 186,330 ÷ 550 × 2 = 169 HP. for two seconds. The above value of horse-power would not hold strictly true unless the rate at which the gate closed was proportional to the rate at which the water column slowed up; but the total foot pounds expended on the wheel would be as above stated.

It is evident that the above amount of work done upon the wheel while the water column is slowing up, would tend to make the speed of the water-wheel run high if the governor only half closed the gates. In fact, the governor would have to set the gates much nearer closed than one-half; or, to speak more accurately, the governor would, at each instant of time, have to hold the gates at such a position that the power developed by the wheel, due to the working head plus the instantaneous value of power being developed by the slowing water column, equalled the load upon the wheel.

This might be found to be quite unfeasible, for the pressure developed on the closed pipe and wheel case might be dangerous, or the gate might be too ponderous or too badly rigged to permit of the requisite promptness of motion.

The maximum pressure which would be developed at any instant of time at the water-wheel, would be an impossible thing to calculate without knowing a great deal more about the venting areas and time ratio of closing them than can ordinarily be found out in practice. All that can be predetermined is what may be called, for want of a better term, the time-average pressure. This can easily be determined as follows:

Let P = the time average pressure.
L = the length of the closed flume in feet.
V = the water velocity in feet per second.
T = the time in seconds in which the water velocity is arrested.
K = the area of a square inch expressed in square feet = .00694.

Then

$$P = \frac{K \times 62.4 \times L \times V}{32.2 \times T}. \qquad (10)$$

It will be observed that $\frac{K \times 62.4}{32.2} = .01324$ is a constant, call this K_1 and the formula becomes

$$P = \frac{K_1 \times L \times V}{T}. \qquad (11)$$

Applying this to the flume we have been discussing in which

$$L = 300; \quad V = 2; \quad T = 2;$$

we have

$$P = \frac{.01324 \times 300 \times 2}{2} = 3.97.$$

As a water column 1 ft. high exerts a pressure of 43 lbs. per sq. in., it follows that a pressure of 3.97 lbs. per sq. in. represents a head of 3.97 ÷ .43 = 9.2 ft. In other words, if the pressure on the wheel could have been kept constant all the time the water column was slowing up from 4 ft. per second to 2 ft. per second, the wheel would have been working under 9 + 9.2 = 18.2 ft. of head, instead of under 9 ft. of head as it should have been.

From experience we know that it is impossible to close

*Condensed from a paper read at the Boston meeting of the American Institute of Electrical Engineers.
†Chief Engineer, Lombard Water Wheel Governor Co., 61 Hampshire St., Boston, Mass.

the water-wheel gates at such a rate as to keep the pressure constant, and as a matter of fact, during some portion of the two seconds the water pressure would have been greatly in excess of 3.97 lbs. per sq. in. above normal, with a correspondingly large disturbance of the speed.

We may note a curious fact in this connection. With a water-wheel set like No. 2, working at nearly full gate, and if under these conditions a large portion of the load is instantly thrown off and the governor is of unsuitable design and does not compensate for the kinetic energy of the slowing water column, it may be found by experiment that the speed will run higher than though there were no governor at all. This is for the reason that for an interval of time the wheel is working under light load and a greatly increased head, and there is, consequently, a greatly increased speed; or, we may say the amount of energy applied to the wheel under the increased pressure, even though the gate areas have been somewhat reduced by the governor, is greater than would have been the case had the gates not been moved at all.

The first remedy which suggests itself is to place large relief valves near the wheel case, so that they will open and let the water escape if the water much exceeds the static head. This would help matters somewhat upon load suddenly going off, but would it help matters upon load suddenly going on? Let us examine this matter.

Suppose the wheel is working at half load with the water column moving at a rate of 2 ft. per second, and the whole load is instantly thrown on the wheel. The governor will promptly open the gate wide, but the water-wheel cannot develop its whole power until the water column has attained a velocity of 4 ft. per second. To gain this extra 2 ft. per second, the water column must have expended upon it the same amount of work which it expended in losing its 2 ft. per second, namely, 186,330 ft. lbs., and this must be deducted from the work the wheel will do normally at full gate; so that the instantaneous value of power developed by the wheel while the water column is gaining velocity would equal the normal power of the wheel at full gate minus the instantaneous value of power being expended upon the water column in getting up to speed.

It is evident that the speed of the water-wheel would fall considerably below normal and there would be absolutely no remedy for it in the present state of the art. I say this advisedly and have not forgotten the question of fly-wheels, which is undoubtedly in all of your minds at the present moment.

I wish to emphasize this line of reasoning, because it is, perhaps, the most important thing to be considered in setting water-wheels where speed regulation is a desideratum. We can, in an imperfect way, provide for the expenditure of the energy necessary to slow up a water column, but there is no way to make a water column, while gaining velocity, do the work it is capable of when it has arrived at full velocity.

The important fact to which I want to especially call your attention is that the difficulty is measured not only by the length of the closed flume, but is inversely proportional to the size of the angle of hydraulic slope. When the sine becomes 1; that is, when the angle is 90°,—or in other words, when the closed flume is vertical,—then the difficulties due to the fact that water moves slowly under the influence of gravity, have reached their minimum and the speed regulation will be the best obtainable. As the sine of the angle of hydraulic slope grows less, then the obtainable regulation grows worse.

There is one way in which the difficulties attendant upon a small angle of hydraulic slope may be in a measure compensated for, and that is by means of a stand pipe. In an electric plant, it is not usually of such importance that a load change amounting to the full capacity of the wheels be followed by a small speed variation, as that the comparatively large loads which go off and on for short intervals of time shall not disturb the speed to any great extent. Here is where the stand pipe is of value. If a portion of the load goes off instantly, and the correctly designed governor promptly closes the gates to the correct position, the excess of water will flow out over the top of the stand pipe and the water velocity in the flume will not be arrested so promptly as though there were no stand pipe; neither will the pressure at the wheel be much increased. To obtain these results, the stand pipe should be only a very little higher than the water level in the pond. It should be located as near the wheels as possible, and its top should be turned over so that the escaping water can be led to some convenient point of discharge.

If, after a load has gone off instantly, it comes on again in a short interval of time, it finds the water velocity in the flume but little diminished, and also the vertical water column in the stand pipe is ready to apply its energy to the water-wheel in the most advantageous manner. To make the last factor of much practical use, the cross section of the stand pipe must be sufficiently large to prevent the level of the enclosed water column from falling much while the water in the closed flume is gaining its lost velocity. As a general statement, the larger the diameter of the stand pipe and the less its height above the hydrostatic level, the better will be the speed regulation. There has not, as yet, been sufficient practical experience with stand pipes to formulate rules which will solve the least diameter which will result in any desired degree of speed regulation. In the writer's experience, it has been found that the use of a stand pipe of ample porportions will render a plant governable within very close limits under ordinary operative conditions which had proved to be utterly ungovernable before the stand pipe was installed.

It also gives perfect protection against dangerous water pressures being developed when circuit breakers open, or when, for accidental reasons, it is necessary to shut down the water-wheels instantly.

It is usually the case that part of the head utilized in modern plants is below the water-wheel in the shape of a draft tube; in fact, where horizontal wheels are used, it is practically necessary to have them a number of feet above tail water level for convenience of connection to the driven machinery. The same general rule holds good in regard to draft tubes, which, we have found, applies to closed flumes. They should be as short and as nearly vertical as possible. The maximum vertical length of a draft tube is, of course, limited by the atmospheric pressure. The water stands in the draft tube for the same reason that mercury stands in a barometer. Atmospheric pressure holds mercury up in the barometer tube,—let us say 30 ins. or $2\frac{1}{2}$ ft.,—therefore it will hold water up in the draft tube $2.5 \times 13.6 = 34$ ft.; that is, it would do so if the draft tube were air tight. The external atmospheric pressure at the top of such a draft tube would be 14.7 lbs. per sq. in. There are few draft tubes that would stand that pressure without leaking air. This fact is well recognized by hydraulic engineers, and it is rare to find draft tubes 25 ft. high from tail water level to water-wheel centers. If the water-wheel is likely to be subjected to large load variations, it is very desirable that the draft tube should have a much less vertical height for the following reason:

At the bottom of a 25-ft. vertical draft tube the atmospheric pressure is forcing the water up with a pressure of 14.7 per sq. in., and the weight of the water is pressing down with a pressure of 10.75 lbs. per sq. in.; that is, the difference between the air pressure and the weight is $14.7 - 10.75 = 3.95$ lbs. Now, if the water velocity in the draft tube is suddenly arrested by shutting the water-wheel gates, the kinetic energy of the slowing water column will be found in the downward momentum of the water. This may easily create a downward pressure greater than 3.95 lbs. per sq. in., in which case a vacuum would be formed in the upper part of the draft tube and the column of water would sink in the draft tube and immediately after would rush upward again striking the bottom of the wheel with great violence. If we were so fortunate as to escape an accident of the kind above described we should find that with a draft tube of considerable height there is a tendency for air to leak in, and this, under the negative pressure of the weight of the water, expands into a partial vacuum so that the draft tube will be only partly filled with water, and as the position of the water-wheel gates varies as the load changes, the water column in the draft tube will sway up and down producing the effect of a pulsating head on the water-wheel. This is very detrimental to good speed regulation, and is a very common annoyance encountered in practice.

Air chambers on flumes, to give protection against water hammer effects, are of very little practical use unless of ample size, even if they are full of air. The writer examined a plant so located that the bursting of the flume would have destroyed the whole plant and ruined an investment of at least $100,000. At the lower end of the flume was a large air chamber. The superintendent in charge pointed with pride to it, and confidently expressed the belief that it afforded ample protection against the dangerous strains on the flume due to water hammer. Upon examining the air chamber it was found to be entirely filled with water, and it had probably been in that condition for a considerable length of time. Water under pressure absorbs air with great facility. An air chamber should be provided with an air pump which may be readily connected to some convenient source of power, and with a gage glass to show the water level. When so arranged, and if of ample size, it affords considerable safety against pressure developed when load goes off suddenly; but it is of no practical use as an aid to the governor in maintaining constant speed.

Aside from designing the water column along the lines already suggested, so that the water may gain its working velocity in the least possible time and also so that it may add to or take from the water-wheel the least amount of the kinetic energy of the water, the next most important thing is the design of the water-wheel gates and the method of connecting them to the governor.

As has already been pointed out, the gates are of necessity large and heavy, and yet they must be moved with great promptness and precision. The writer has had occasion to investigate with more or less accuracy the number of foot pounds necessary to open and close the gates of several hundred water-wheels, and the surprisingly large variation in the amount of energy required, leads him inevitably to the conclusion that this matter has not received in many cases the careful engineering treatment which it deserves.

Water-wheels are of many designs and sizes, and work under many different conditions of head, but there would seem to be no adequate reason why the gate of one water-wheel developing a certain amount of power under a given head should require only 1,000 ft. lbs. to completely open it, and the gate of another water-wheel of different make, developing the same amount of power under the same head, should require 60,000 ft. lbs. Yet such has been found to be the case. The above example, taken from actual practice, is by no means unusual; and scores of such cases could be cited showing relatively absurd figures.

Some builders prefer to use cylinder gates on their wheels; others prefer wicket gates; while still others adhere to register gates. It is not the intention of this paper to enter into a critical comparison of the merits of these various types of gate, and, in fact, from the standpoint of speed regulation, no such comparison is necessary for the good and sufficient reason that there are wheels on the market of all three of the above kinds which show little to be desired in the ease with which the gates may be moved. It is also true that there are makes of wheels of all three kinds which cannot be governed accurately under variable loads, simply for the reason that their gates cannot be moved quickly enough.

It is often necessary to start a gate from a rest and completely open or close it in two or three seconds, or give it a proportionately smaller motion in a proportionately shorter space of time. Or what is still more severe, it is often necessary that while a gate is opening or closing its motion be instantly stopped and reversed.

If one will watch a thoroughly first-class governor handling the gates of a water-wheel which is driving an electric generator operating on a variable load, one is convinced of the fact that the governor has to develop considerable amounts of energy in surprisingly short spaces of time, and that the rigging connecting the governor and the gates is subjected necessarily to considerable strain, from which it follows that the easier the gates move the less chance there is of stripping gears and twisting off shafts; to say nothing of relieving the governor itself of unnecessary strain.

All gears between governor and gate,—except immersed racks and pinions,—should be cut, of first-class workmanship and not too large for the work required of them. The latter precaution is necessary to prevent the MV^2 energy in the gears themselves destroying the rigging when the direction of motion is suddenly reversed. Shafts should be of just sufficient size to give an ample factor of safety, and prevent torsional difficulties, for it is absolutely necessary that the smallest amount of motion of the governor shall be transmitted accurately to the water-wheel gate. Lost motion in gears, and twisting of shafts are fatal to good regulation. Hand-wheels should be so arranged that they may be entirely thrown out of connection with the rigging while the governor is in action, or they may be unkeyed in some simple manner.

Counterbalancing a gate is not the equivalent of having it in water balance. All vertical cylinder gates are necessarily out of balance to an amount equal to their immersed weight, but that is usually so small that it is not necessary to counteract it with a counterweight.

Some designs of gate show a violent tendency to close or stay closed. It is the custom to counterbalance such gates, and this practice leads to endless trouble on account of the kinetic energy in the counterweight. It being often necessary to reverse the motion of the counterweight suddenly, the kinetic energy expended at the amount of reversal is often sufficient to wreck the rigging. If counterweights must be used, it should be remembered that their kinetic energy is proportional to their weight, but also proportional to the square of their velocities; from which it follows that a heavy, slow-moving weight does less damage than a light, rapid-moving one.

It has been the custom of late to cast onto cylinder gates, fingers reaching out between the guides. These innocent looking devices, which are supposed to guide the water into the wheel properly, and hence raise its efficiency, are a source of no end of trouble when it comes to moving the gate quickly enough to produce good speed regulation. The direction of motion of the water as it enters the wheel is always such that it presses these fingers downward with tremendous force, giving the gate a strong tendency to close. By removing these fingers, the amount of energy necessary to open the gates can always be reduced by at least one-half, and oftentimes more than that. There are scores of water-wheels on record which were so much out of balance, due to the fingers on the gates, that it was found impracticable to govern them satisfactorily on account of gears stripping and shafts twisting off. In the writer's experience, it has always been found practicable to govern these wheels by removing the fingers.

Now, as to the question of efficiency. The writer has often had to meet the argument of the few per cent. of efficiency supposed to be lost by removing these fingers, and to answer this question, tests have been made which show that there is no material gain in the efficiency of a water-wheel set under ordinary working conditions, by attaching fingers to the gate.

Wicket gates also have their peculiarities. Some makers hang them in such a manner that they are practically in water balance in any position, and may be readily opened and closed with a small expenditure of energy. Such gates leave little to be desired, and wheels fitted with gates so designed may be governed with the greatest degree of exactness and without fear of injury to the rigging or governor. The writer has observed, however, that some wicket gates which move very easily have so much lost motion that in certain portions they tend to flop (no other word conveys the idea) first in one direction and then in the other, causing a pulsating speed which is very annoying and apparently inexplicable until one has investigated the cause. The danger of lost motion is greater with wicket than with cylinder gates, but with proper construction it is found in practice that lost motion may be entirely eliminated from wicket gates.

In some wicket-gate wheels the wickets are hinged at one end and attached by the other end by tangential arms to a banjo, which in turn is geared to the shaft going to the governor. Such gates are entirely out of water balance when partly closed, and the more they are closed the more they are out of balance. Wheels with gates of this description are very difficult to govern. Frequently the strength of the wickets and radical arms is not sufficient to withstand the water pressure, even if sufficient energy can be supplied to them. In recent practice a wheel of this description was found to require some 40,000 ft. lbs. to open it. Another wicket-gate wheel of different make but the same rated H. P. was found to require only 5,000 ft. lbs. to open it. As another recent instance, it was found that a pair of wicket-gate wheels of the kind described above required 19,000 ft. lbs. to open them; another pair of different make but the same rated H. P. required but 2,500 ft. lbs. to open them. The wheels compared above were working under the same head.

AN ENGLISH ENGINEER'S COMMENTS ON AMERICAN MUNICIPAL WORK AND ADMINISTRATION.

An impartial and intelligent review of municipal engineering and administration in America, as observed in a few of our larger Eastern cities, was recently presented before the Association of Municipal and County Engineers, at one of the district meetings in London. The author of the paper was Mr. George Livingstone, Assoc. M. Inst. C. E., Surveyor to the Vestry of St. George, Hanover Square. The chief adverse criticism which we have to make upon the paper is the drawing of generalizations from observations in a limited number of cities. So far as these relate to the degrading influences of partisanship in municipal politics, no objections can be raised, but in matters of engineering practice some wrong impressions are conveyed by assuming that the conditions found in a few of our large Eastern cities prevail throughout the country. It is only fair to the author to state that he warned his hearers at the outset that his "remarks will refer particularly to New York, but will apply to American cities generally, of which New York may be taken as the type."

As to the effect of bad politics on city government, Mr. Livingstone says:

To arrive at a clear conception of municipal life and problems in America is no easy matter for a visitor from this side of the Atlantic—especially one who has been in close professional contact with municipal work in his own country—until he grasps as a central idea the important part which politics play in municipal affairs in the United States. Here, indeed, is to be found the essential point of view, the starting point from which the civic life of the Great Republic must be judged. What has been the effect of the political factor in the municipal life of America? To describe it as the curse of municipal government is not using language too strong. A victory at the polls, the mere turning of the political wheel, may be the signal for the discharge of admirable public servants, endowed with the best qualifications of the ideal municipal officer and animated with a lofty conception of his duties and responsibilities. Such an official may conceivably have been in office just long enough to enable him to learn the needs of his district, and the best means of meeting them and of remedying defects, when some sudden political change deprives him of office, perhaps to see his place filled by a man whose sole claim to the position is based on adherence to the successful political ticket. Nor is this all. An official, no matter how admirable he may have been in the discharge of his duties, how much initiative he may have shown, or how great the public improvements he may have effected during his tenure of office, may ultimately be rewarded only by opprobrium and abuse if he should happen to be associated with the unpopular political party.

The extent to which our street railway systems are developed and used, including the transfer system, is commented on. The noise due to the elevated railway system of New York is spoken of as "deafening and interminable," while all its advantages

are more than counterbalanced by its disadvantages as a dirt distributor and noise producer. Cinders, ashes, dust and water sift down on the roadway below, and the state of Third, Sixth and Ninth avenues would strike a London surveyor with dismay.

A bad slip is made in classing Washington with the other cities in which the overhead trolley is used, whereas it was the pioneer city in this country to introduce the underground electric conduit system, and has used it nearly to the exclusion of the overhead trolley. Possibly the author confused suburban and city lines.

The great advantages of electric railways are pointed out at some length, chief among which the author mentions freeing the streets from the crowding and dirt due to horses. In the matter of motor vehicles we are pronounced backward, although the author says this may be due largely to the great development of electric railways which renders such vehicles, as well as cab service, in less demand than abroad.

Had Mr. Livingstone visited a larger number of cities, his impressions regarding American paving would have been at least more varied. He saw no brick paving, but, in answer to a question, said "he understood that brick was not regarded as altogether a satisfactory material for paving purposes." As our readers know, scores of our central western cities take great pride in their miles of smoothly-paved brick streets. He alluded to the fact that wood is so much in disfavor here and so much used in England, although introduced in the latter country from America. He was impressed with the wide use of asphalt in this country, but said he had seen no sheet or block asphalt here "under such conditions of traffic as those to which the busy London thoroughfares are subject." He added "that every surveyor and every local authority in this country would welcome any pavement that could be relied upon to be non-slippery, durable, and which had a smooth surface."

Mr. Livingstone's comments on the paving of New York's great central thoroughfare, and on paving in general in New York, Baltimore and Philadelphia, are respectfully commended to the public officials, press and people of those cities:

The author ventures to question if there is in any city or town of any rank in Europe a thoroughfare of the size and importance of Broadway in so deplorably defective a condition. The condtion of the roadway and sidewalks of this and adjoining streets is a danger to man and beast. That such a state of affairs is tolerated in so practical and so advanced a community can only be explained by the fact that everything is subordinated to politics, and the municipal officers, as a rule, are merely pawns on the political chessboard. In New York, Baltimore and Philadelphia the author saw many important residential streets and business thoroughfares in which neither roadway nor footway had been repaired for years. The fact that many of the streets are composed of worn cobblestones may possibly explain to some extent the American distaste for walking. All the more recent paving work is put down under contract, and maintained free of expense for from 5 to 15 years by the contractor. Subsequently they are maintained by the municipality, usually in a slipshod way. For example, the author has seen streets in which openings had been made, in connection with gas or water mains, and had not been filled in for weeks, and even in some cases for months. Such cases, which would not be tolerated in London for 48 hours, are of common occurrence in American cities.

Street cleaning in the better paved streets of New York, the author thought, was generally "superior to that of the London streets, but it should be remembered that is no doubt largely due to the small amount of horse traffic." In connection with this subject the author paid a high tribute to the work of the late Col. Waring.

As to the collection and disposal of garbage and other refuse, the following conclusions are given:

It can safely be said, therefore, that the dust problem is as far removed from solution among our go-ahead American cousins as it is among ourselves, and, on the whole, the author is inclined to the opinion that our own methods for the collection, removal and disposal of house refuse are, in spite of the worry they cause officials, superior to the methods in vogue on the other side of the Atlantic.

The problem of snow removal, the author thinks, is also as far from scientific solution in New York as in London.

Perhaps the highest commendation expressed in the paper is of the water supply of New York, which the author thinks it is no exaggeration to say is the finest in the world. He says the appreciation of this water is shown by the average daily consumption of 112 gallons per capita, and thinks it doubtful if this is equalled "in any other city in the world." Had he qualified this last statement by saying, outside of America, probably he would have been correct, but compared with the 150 to 250 gallons per capita per day supplied in some of our other cities and towns, New Yorkers are quite saving of their water. Still it is perfectly true that this figure for New York represents much useless waste, and it is not strange that Mr. Livingstone was impressed by it when a reference to the last report of the Local Government Board shows that in 1897 the eight metropolitan water companies of London supplied to 5,703,404 people an average of only 43 (U. S.) gallons each per day, the range for the different companies being from 36 to 57 gallons. We may mention here that so far back as 1890 there were 17 of the 50 largest cities in the United States that made way with 112 (U. S.) gallons, or over per capita per day, the highest being Allegheny, with 238 gallons. At that time Philadelphia was down to 132 gallons, against over 200 now. Many of the other cities in the list have doubtless increased their consumption since, but it is only charitable to hope that the rate of increase has been lower than in the case of Philadelphia.

In passing, the author expresses "the opinion that in America they are ahead of us in all matters connected with plumbing, alike in regard to appearance, workmanship and details." He was surprised to find an almost absolute lack of public conveniences. He says on this subject:

On making inquiries he found that the absence of public conveniences is not so serious a disadvantage as it at first sight appears. Every man has free access to the rear of saloons and hairdressers' shops, and it is a general custom for well-dressed men to go into the big hotels and use them just as if they were residents. Ample accommodation is provided for women in all stores, hotels, etc. As no complaints are heard, the existing arrangements would seem to give satisfaction; but there is something free and easy about them that would not commend itself to our more conventional ideas.

Some good, common-sense reflections on the relative advantages of public baths and the extension of the introduction of bath tubs in private families are worth recording for the interest of sanitarians, engineers and water-works officials here:

The difference between London and New York in regard to the provision of public baths suggest a few general reflections. While these establishments are, no doubt, very useful and meet a great want in England, the author is not quite sure that they always benefit the class for whom they are chiefly intended—namely, the artisan and working class. His own view, and the one he would like to see put into practice, is that every working man's house should be provided with a bath, which, in his opinion, is, from the sanitary point of view, almost as essential as a water-closet. When the London artisan reaches home in the evening, more or less tired, the nearest public bath is probably some considerable distance away, and in these circumstances there is very little inducement for him to take advantage of the facilities provided. In addition, the price is often prohibitive. In many cases the public baths are closed on the only day—namely, Sunday—on which the artisan has sufficient time at his disposal to avail himself of the luxury of a bath. In the author's opinion it is infinitely more desirable that the working man should have the privilege of a bath for himself, his wife and his family, in the privacy of his own home.

The poor telephone service of England may be inferred from the few sentences given below from Mr. Livingstone's remarks on this subject:

In the United States the telephone as a means of communication has been brought to great perfection. The telephone system in New York is probably the best in the world; there is no delay, the number is switched on at once, and one can make an appointment or ask a man to dinner within five minutes of application. This the author proved by personal experience. * * * In London the "flat rate" system of charging is still in use, whereas in New York the system which has been in use for several years past is known as the "message rate system," and consists of a sliding scale based on the extent to which the subscriber avails himself of the service. This system, combined with the great convenience afforded, brings the use of the telephone within the reach of practically every householder. Excellent systems are found in other American cities, and the rates are even cheaper than in New York. In England not a few municipal authorities, including the London County Council, are anxious to add a telephone service to their already numerous responsibilities, while many people, with greater reason, advocate that the entire undertaking, like the telegraph and postal services, should be controlled by the state. If the present service, which is carried on under considerable difficulties were organized with anything like the completeness of the American system, the agitation against it would probably not have assumed such serious dimensions.

Some editorial comment on the paper, with one or two further extracts, is given elsewhere in this issue. We are indebted to the London "Surveyor" for the opportunity to present the above abstract of Mr. Livingstone's paper.

STEEL STANDPIPES instead of tanks elevated on towers, are being used at the water stations of two or three railways. The Atchison, Topeka & Santa Fe Ry. has three standard sizes of such tanks, 29 ft., 43 ft. and 60 ft. high, all 24 ft. inside diameter. The courses are 84 to 105 ins. in height, with plates 12 ft. 6¾ ins. long and 7-16 ins. to ¼-in. thick. The flanged end of the horizontal pipe from the valve is riveted to the plate, as is also the flange of the bracket pipe to which the hinged supply pipe is attached.

A NOVEL DESIGN FOR A STEEL BIN FOR THE STORAGE OF COAL, GRAIN, SAND OR CEMENT.*

By A. S. Berquist, C. E.†

In connection with the design and erection of the extensive plant of the American Coffee Co., of Brooklyn, N. Y., which has a capacity of nearly 1,000,000 lbs. of coffee every 24 hours, and is, perhaps, the largest of its kind in the world, it devolved upon the writer to provide a coal storage bin for the power plant. A plan for a coal bunker of the customary form had already been prepared when the question of the proper design of coal bins was raised by the story of the disastrous failure of a similar structure in Paterson, N. J., published in Engineering News for Aug. 26, 1897. The strain sheet of the bin was at

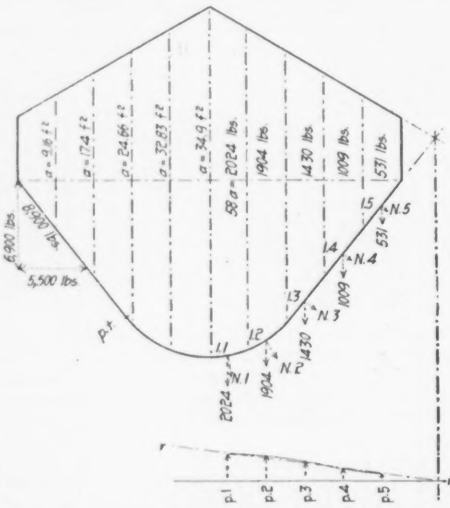


Fig. 1.—Diagram Showing Shape of Curved Bottom and Distribution of Load in a Hanging Coal Bin.

once brought out and carefully examined; during this process it occurred to the writer that if the bottom of the bunker were shaped with due regard to the strains produced by the stored material, no bracing would be necessary, and as the bracing in a bunker requires the most material, a substantial saving in the cost of the structure would be effected. After several trials a curve similar to the one shown at Fig. 1 was plotted, experimented with, and found to answer all practical purposes. The bin as finally constructed is shown in Fig. 2.

This figure it will be seen is divided into ten vertical strips of equal width, of which the area is figured and noted on the left-hand section; on the right this area is multiplied by 58, the assumed weight of 1 cu. ft. of coal, for the strain diagram, and eventually by 56 for the capacity.

These forces are considered to act on the middle of the section where they are laid out on the curve to scale, and the parallelogram of forces completed. Just below the curve the same forces are also drawn to scale at their respective distances from the centre of the curve, and it will be noticed that the load equation gives very nearly a straight line.

Reverting to Fig. 1, it will be seen that the normal forces to the curve decrease regularly from N 1 to N 5. From this we conclude that the radius of curvature should increase from a minimum at the apex to a maximum where the curve joins the side of the bunker. Now, as a matter of fact (shown by experiment), from the point marked (p t) in Fig. 1 to the junction of the side of the bunker with the vertical side, the curve deviates very little from a straight line, and in the execution of the design it might be so considered, because the plate is well able to take care of the small amount of curvature due to the loading of the bunker.

The strains which are of the most interest are those shown in the parallelogram of forces at the left-hand side of Fig. 1. The vertical reaction for a unit section of the bunker is evidently half the load on the bunker, from this the strain in the plate and the horizontal strain between the two sides of the bunker is easily found, either graphically or analytically.

It might be argued that this analysis does not take in consideration horizontal stresses set up in the bunker due to any sliding movement of the load material. While this is true, these forces need not be considered, because the sum of the horizontal components of the normal forces, N 1 to N 5, will be found to be insignificant in comparison with the sum of the vertical forces. As a matter of fact accurate measurements on a completed structure have shown that the lowest point of the curve of the bunker only rises ⅜-in. for a full load, which is readily explained by the curvature in the plate from the point (p t) to the point of suspension.

Fig. 3 shows a complete cross-section of the bunker as constructed. The side plates are bolted to the web of the girder which extends below the lower chord angles. To this same joint is also bolted a 9-in. I-beam, which transmits the strain to the channel-bar struts, located at each pair of columns and midway between the same.

Fig. 4 shows a longitudinal section from column to column, and also the chutes for drawing off the stored material; it may be noticed in this connection that the bunker possesess the great advantage of being almost completely self-emptying.

The flat ends of the bunker are each stiffened and braced by six I-beams rivetted to the inside and fastened to the sloping sides of the bunker by suitable angles.

In order to save the plates from the injurious action of dilute sulphuric acid which forms from the sulphur and moisture in the coal, the inside of the bunker is lined with 1½ ins. of cement plaster, laid upon metal lath, such as is furnished by the New York Expanded Metal Co. for partitions. The bin supporting columns and housing were built by the Berlin Iron & Bridge Co., of East Berlin, Conn.

The saving in material affected by this design amounts to 76% over the original design, and in general this method of construction effects a saving of from 50 to 82%.

Mr. Bertel Asp has written the following analytical investigation of the design of the bunker, which is herewith submitted:

The shape of the bunker is the curve of equilibrium for a cord suspended from two fixed points and continuously loaded with a load greatest at the centre and diminishing to zero at the points of suspension. This curve is a catenary, the equation of which may be stated:

$$y = f(x)$$

The law of the load may be expressed by the equation:

$$p = \varphi(x)$$

Between these two equations we have the relation:

$$y = \frac{1}{H} \int dx \int \varphi(x)\, dx + C_1 x + C_2.$$

This may be shown thus:

Consider an elementary piece of the catenary (A Fig. 5) with the load p d x, the stresses S and S + d s. The components of S and S + d s are V, H, and V + d V, and H, respectively.

The Σ Vert. Comp. = zero gives:

$$V + dV - V - p\,dx = 0,$$

or

$$\text{(a)}\quad dV = p\,dx.$$

Furthermore, we have the proportion:

$$\frac{dy}{dx} = \frac{V}{H}.$$

H being constant we obtain by differentiating:

$$\frac{d^2 y}{dx^2}\, dx = \frac{dV}{H}.$$

By substituting from (a) and reducing, we get:

$$\text{(b)}\quad \frac{d^2 y}{dx^2} = \frac{p}{H} = \frac{\varphi(x)}{H},$$

by integration:

$$\frac{dy}{dx} = \frac{1}{H} \int \varphi(x)\, dx + C_1$$

and

$$y = \frac{1}{H} \int dx \int \varphi(x)\, dx + C_1 x + C_2.$$

If we know what function (y) is of (x), we can by double integration find the equation of the catenary. Now to simplify matters we will presume that the load is regularly decreasing from a certain maximum P to zero. (This assumption is practically close enough, and the bunker may in fact be so loaded that it will be true.) Then the curve representing the load is a straight line, and we have the proportion. (See B, Fig. 5.)

$$\frac{p}{P} = \frac{l - x}{l},$$

whence

$$p = \frac{l - x}{l} P. \qquad (1)$$

Substituting this value of p in equation (b), we obtain:

$$\frac{d^2 y}{dx^2} = \frac{l - x}{l} \frac{P}{H} \therefore \frac{d^2 y}{dx^2} = \frac{P}{H} - \frac{P}{l H} x.$$

By the first integration we get:

$$\frac{dy}{dx} = \frac{P}{H} x - \frac{P}{2 l H} x^2 + C_1.$$

The constant is determined by the location of the y-axis; for as x = 0 the tang. $\frac{dy}{dx} = 0$, consequently $C_1 = 0$.

By the second integration we get:

$$y = \frac{P}{2H} x^2 - \frac{P x^3}{6 l H} + C_2.$$

As the origin is at the vertex, x = 0 and also y = 0, therefore $C_2 = 0$.

$$y = \frac{P}{2H} x^2 - \frac{P}{6 l H} x^3. \qquad (2)$$

When x = l, then:

$$V = \frac{P}{2H} l^2 - \frac{P}{6H} l^2 = \frac{P l^2}{3H},$$

or

$$H = \frac{P l^2}{3V}. \qquad (3)$$

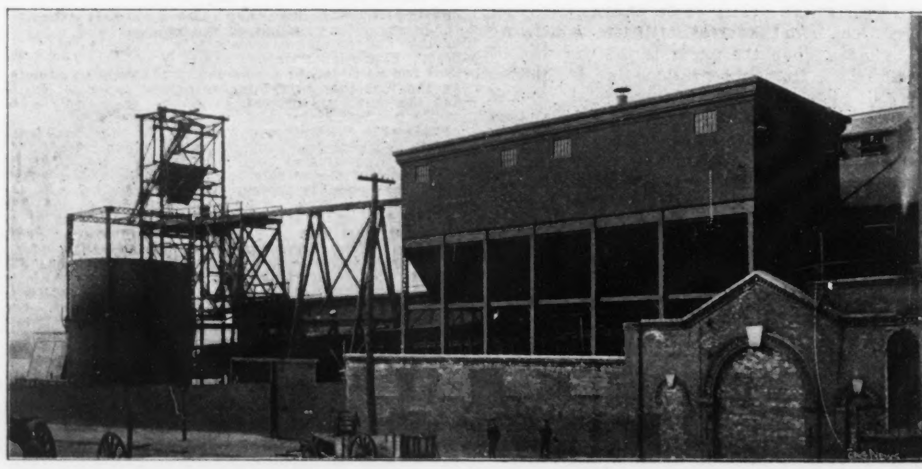


FIG. 2.—VIEW OF COAL STORAGE BIN AT THE WORKS OF THE AMERICAN COFFEE CO., BROOKLYN, N. Y.

A. S. Berquist, Designer.

*Patented in May, 1899.
†108 Wilson St., Brooklyn, N. Y.

Substituting this value of H in equation (2) we obtain:

$$y = \frac{3}{2}\frac{V P x^2}{P l^2} - \frac{V P x^3}{2 P l^3}, \qquad (4)$$

or

$$y = \frac{1}{2}\frac{V}{l^2}\left[3 x^2 - \frac{x^3}{l}\right], \qquad (5)$$

which is the final equation of our catenary. Equation (4) shows that the shape of the bunker is independent of the maximum load, and is determined only by the width and depth. These depend upon local conditions and the required capacity. The capacity is dependent upon the area of the cross-section A. (B. Fig. 5.)

$$A = 2\, l\, V - 2\, a.$$

But:

$$a = \int_0^l f(x)\, dx = \frac{3}{2}\frac{V}{l^2}\int_0^l x^2\, dx - \frac{V}{2\, l^3}\int_0^l x^3\, dx$$

$$= \frac{3}{2}\frac{V}{l^2}\cdot\frac{l^3}{3} - \frac{1}{2}\frac{V}{l^3}\cdot\frac{l^4}{4} = \frac{V\, l}{2} - \frac{V\, l}{8} = \frac{3}{8} V\, l,$$

whence

$$A = 2\, l\, V - \tfrac{3}{4} V\, l = 1\tfrac{1}{4} V\, l.$$

Then letting C represent the capacity, L the length of the bunker, W the entire width (and V the depth as before) we get:

$$C = \tfrac{5}{8} W\, V\, l.$$

C, Fig. 5, shows the profile of a bunker 20 ft. wide and 10 ft. deep. The ordinates are figured from equation (5).

The catenary may be laid out graphically as an equilibrium polygon going through the fixed points A. and C. (See D., Fig. 5.) The loads P_1 P_2 — P_{10} are laid off in the force polygon to which we choose an arbitrary pole (0) and draw the corresponding funicular polygon. We know from the rule of affinity between funicular polygons that the intersection points between corresponding sides lay on a straight line. Since the side through C must be horizontal we find readily that A D is the axis of affinity and are thus able to construct our equilibrium polygon which is really constituted by the tangents to the curve in C, Fig. 5.

For the construction we need in addition to the shape the stresses H. V. S. and Sx (see E, Fig. 5) at one or more points where a splice may be necessary. H may be figured from equation (3) and V. S. and Sx obtained graphically as shown in the figure or V may be figured, being equal to ½ the load on the cross-section of the bunker, and S, Sx and H obtained graphically.

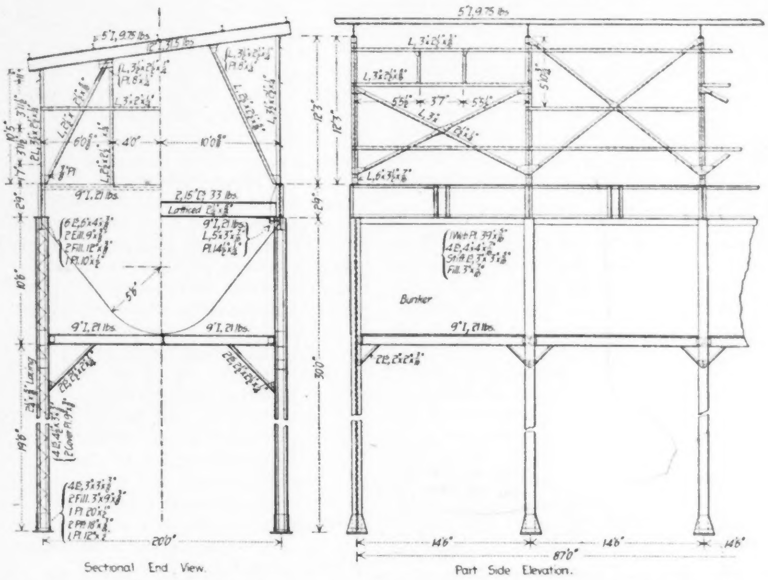


FIG. 3.—PART SIDE ELEVATION AND SECTIONAL END VIEW OF HANGING COAL BIN.

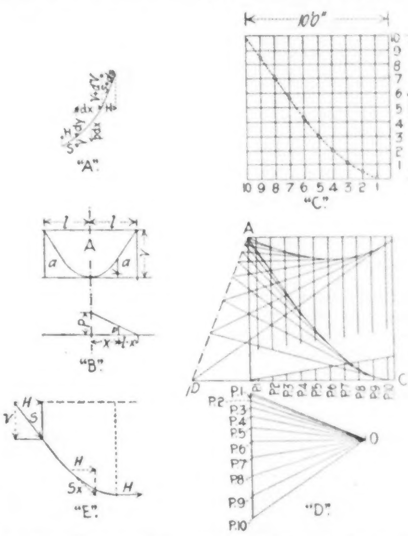


Fig. 5.—Diagram Showing Method of Calculating Strains in Sides and Bottom of Bin.

A FIRE TEST OF A FIRE-PROOF FLOOR of steel joists filled with concrete was made at the testing plant of the British Fire Prevention Committee on May 25, 1899. The floor was built in one of the standard 10 x 10 ft. testing houses and consisted of four 7-in. I-beams, spaced 3 ft. apart c. to c. and filled flush with the flanges with five parts coke breeze and one part Portland cement concrete, laid on sheets of old corrugated iron resting on the bottom flanges. This corrugated iron served merely as a centering on which to place the concrete. Ceiling joists of 2 x 3 in. timber spaced 1 ft. 4 ins. apart were hung from the I-beams by iron hooks. Metal lath was nailed to these joists and plastered to form a suspended ceiling. The fire lasted 1¼ hrs. at a temperature rising gradually to 2 000° F., and then water was turned onto the ceiling through a ½ in. hose for 3 mins. The floor carried a superficial load of 168 lbs. per sq. ft. The suspended ceiling fell during the test. The floor deflected during the test 2¾ ins. in the center, but subsequently returned to within 1-in. of level. The concrete was slightly disintegrated on the under side, but the fire did not pass through the floor.

FIRE TESTS OF PARTITIONS were conducted at the plant of the British Fire Prevention Committee in London on May 25. The object of the test was to record the effect on the partitions of a fierce fire of one hour's duration, gradually increasing to 1900° F., followed suddenly by the application of water for three minutes and the consequent rapid cooling. Two different partitions were tested, each having two variations of construction. The first partition was lath and plaster construction, wooden lathing and plain wire lathing being the two variations in construction; the second partition was of brick filled or brick-nogged construction, the two variations of construction being brick laid on edge and brick laid flat. The area of each of the four constructions was 3½ x 7½ ft., or 26 sq. ft. Only ordinary building materials obtained in the open market were employed. The lath and plaster partition was made with 2 x 4-in. studs, head and sill, with one row of 2 x 4-in. bridging. The studs were spaced 16 ins. c. to c. At one end of the partition there was a door with 4 x 3 in. rebated door posts and a 6½ ft. x 2 ft. 7 ins. panneled door. This end of the partition, including the space over the door, was lathed with wire lathing 1-16 in. thick and ½-in. mesh secured to the studs by iron staples. The other end of the partition was lathed with fir laths ¼-in. x 1¼ ins., and ⅜-in. apart, butt joints nailed with 1-in. wire nails. The thickness of the plastering was ⅞-in. The brick-nogged partition was made of 3 x 2-in. and 4 x 2-in. studs, cap and sill, spaced 20 ins. c. to c. and bridged about half way up with pieces the full width of the studs. At one end there was a door 6½ x 2⅓ ft. The filling at one end was brick laid on edge in mortar, and at the other end brick laid flat in mortar. The plastering was ⅞-in. thick. The results of the tests were as follows: The lath and plaster partition was practically destroyed. Fire broke through the plastering on wood lath in 28 mins., at about 1,600° F., and through that on wire lath in 40 mins., at about 1,750° F. The brick-nogged partition resisted the passage of the fire for the hour, although the plastering was disintegrated and the studs were charred and the temperature was to 2,000° F.

THE SHIPBUILDING OF THE UNITED KINGDOM, or vessels under construction on June 30, 1899, aggregated 541 steamers of 1,382,855 tons and 27 sailing ships of 3,482 tons. The total was 568 vessels of 1,386,367 tons, as compared with 580 vessels of 1,322,068 tons in 1898. These figures are exclusive of warships. All the sailing ships were under 1,000 tons. The tonnage of the steamers ranged as follows: 230 of 999 tons or less, 218 of 1,000 to 4,999 tons, 64 of 5,000 to 7,999 tons, 12 of 8,000 to 9,999 tons, and 17 of 10,000 tons or over.

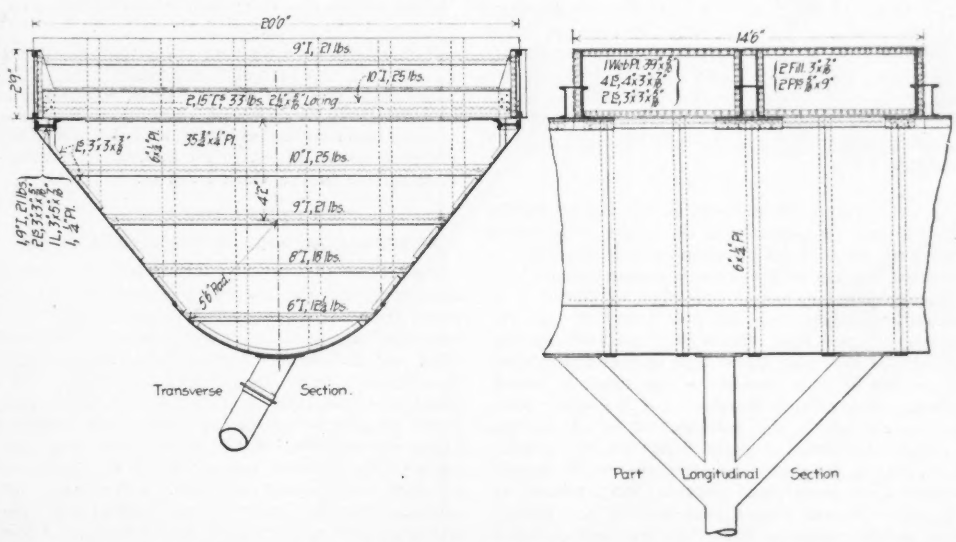


FIG. 4.—CROSS AND PART LONGITUDINAL SECTIONS OF BIN SHOWING EMPTYING SPOUT.

THE WATER-POWER PLANT at the Snoqualmie Falls, in Washington, has been put in experimental operation, with successful results. The water wheels used are of a somewhat new type, designed by Mr. Thos. T. Johnston, the chief engineer, and they are said to deliver nearly 90% of the power developed by the water under a head of 270 ft.

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In ordering changes of mailing addresses, state BOTH old and new addresses; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 329 means that subscription is paid to the 32d week (that is the issue of Aug. 10) of the year 1899; the change of these figures is the only receipt sent, unless by special request.

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.

Through an error on the part of our lithographer the inset sheet of drawings to accompany the article, entitled "The New Dry Dock for the U. S. Navy at Boston, Mass.," was omitted from some four thousand of the papers sent to our subscribers. To remedy this to the best of our ability, we have mailed copies of the inset rolled in tubes to every subscriber to whom a defective paper was sent. Numerous complaints have already come in—so many that we ask those who have written us to accept this explanation and the receipt of the missing sheet as an acknowledgment of their letters.

A most animated struggle in the United States courts may be expected if St. Louis succeeds in bringing to trial its proposed injunction suit to prevent the use of the great drainage canal which Chicago hopes to put in operation by Dec. 1. A resolution instructing the city attorney of St. Louis to take such action was adopted by the municipal assembly a few days ago, and is printed elsewhere in this number. The issue is stated plainly as involving the purity of the water supply of St. Louis, the pollution of which by the sewage of Chicago is guarded against, the resolution states, only by "the very uncertain benefit which may come from certain proportions of dilution." Other strong language in the resolution is the assertion that "waters once polluted will never by natural processes be made safe for drinking purposes." This last statement evidently was not revised by the city's able engineering advisers. It is interesting to note that the public press of the country, so far as it has expressed itself, sympathizes mainly with St. Louis. While this does not necessarily have any bearing on the merits of the case, being based more on sentiment than on science, yet it is encouraging, for it shows a growing appreciation of the importance of keeping our inland waters pure and of the general menace of sewage pollution.

The recent appointment of a permanent State Sewerage Commission in Connecticut ensures the continuance of the good work begun in 1897 by the temporary commission, whose report we reviewed a few months ago. Most of the members of the new commission were also on the old one, including Messrs. R. A. Cairns, M. Am. Soc. C. E., City Engineer of Waterbury, and Prof. Edw. H. Jenkins, of the Connecticut Experiment Station, at New Haven. The present commission, unlike the first one, is to have a salary ($500 a year each), and is authorized to employ an engineer, chemist and bacteriologist, as needed. The duties of the commission, like the permanent one recently established in New Jersey, are confined mostly to investigating methods of sewage treatment and giving advice on the subject when requested to do so, but the good which may be accomplished in this way is not only so much clear gain, but leads the way to still more important advances.

Nothing seems to strike Englishmen visiting American cities with more force than the extent to which political considerations, in the worst sense of the term, enter into our municipal affairs. Some reflections on this subject by an English municipal engineer are given elsewhere in this issue, in connection with an abstract of a paper containing observations made while on a trip to this country. In order to call attention to the abstract and to lay all possible emphasis on a matter of such vast importance to many of our readers we quote the concluding words of the paper, which ends as it began with some comparisons between English and American municipal government. The author closes his paper as follows:

> The author may conclude with a few words regarding the political aspect of the position of municipal officials in America as contrasted with the position of similar officials here. How different are the arrangements in this country! With us the public servant, so long as he is competent, discharges his duties faithfully, and conducts himself with due propriety, is practically appointed for life, unless it pleases him to relinquish his post. It is of no consequence to him what political party is in office. HIS BUSINESS IS SIMPLY TO PERFORM HIS DUTIES. In England the public official does not, as a rule, take an active part in politics. As a private individual he, no doubt, has his views in such matters, but not in his official capacity. An additional incentive to a public official in England to devote himself to the discharge of his duties is the fact that after years of service he may be awarded a pension in recognition of his work.

That the author of the paper was not alone in his opinions was shown by the comments at the time it was read, the chairman of the meeting remarking:

> However much they could learn about engineering from America, he did not think they had much to learn in regard to municipal administration. If streets in this country were in the same state as American streets were sometimes said to be in, municipal representatives would be turned out and the surveyor probably hanged. The status of the municipal engineer, again, was to them a thing absolutely startling.

We commend these extracts, and the one in the abstract of the paper, to all interested in municipal reform in the United States.

MUNICIPAL STATISTICS IN THE CENSUS OF 1900.

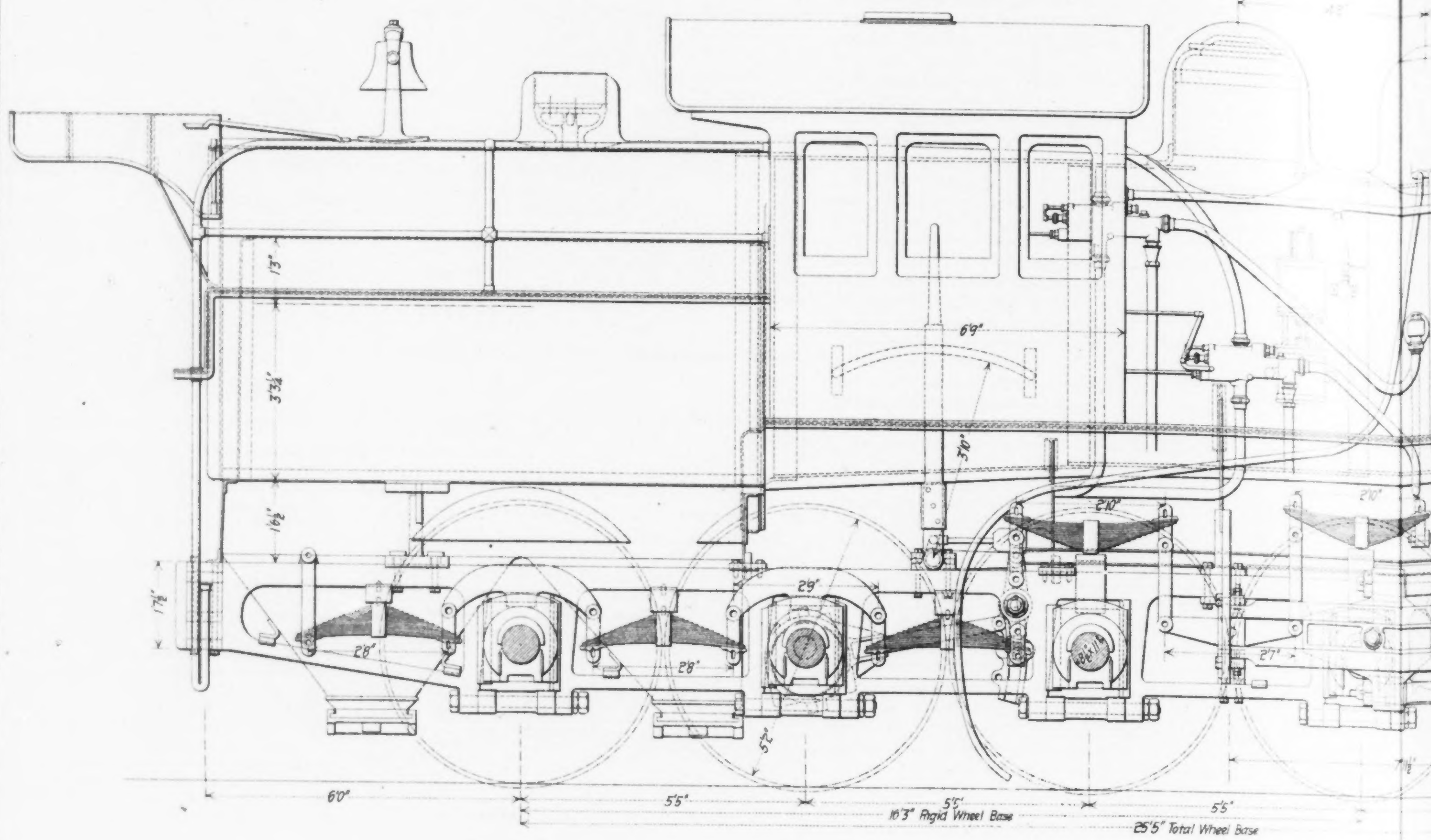
The large and rapidly increasing part which municipal life and activities occupy in our national existence is reflected in the space devoted to municipal statistics in the censuses of 1880 and 1890, and the interest shown in the same subject in connection with the forthcoming census. The American Economic Association recently published an octavo volume of over five hundred pages of criticism of the last census and suggestions for the next one, a portion of which was devoted to municipal inquiries. Of more immediate interest to most of our readers is a resolution adopted at the recent meeting of the American Society of Civil Engineers instructing the Board of Direction to endeavor to have complete statistics of municipal and other public works included in the next census. Although some questions were raised as to the feasibility of the plan, its magnitude and the difficulties involved do not seem to have been appreciated by those who voted for the resolution. That complete and reliable statistics regarding municipal public works and the various conditions affecting them would be of great value to engineers and all other students of municipal problems is not questioned. Such doubts as arise when the subject is mentioned relate to the practicability of securing the desired information through the agency proposed. Not that the machinery in preparation for taking the next census promises to be less effective than that previously in use, for there is great reason to believe that all in all it will be far more effective; but the problems involved are so huge and intricate that nothing short of a permanent bureau of specialists seems likely to be able to collect and digest those complete statistics relating to municipal works called for in the resolution adopted by the American Society of Civil Engineers.

Taking things as we find them, it is to be noted first that the act providing for the twelfth census authorizes the director, among other things, "to collect statistics relating to * * * * social statistics of cities; to public indebtedness, valuation, taxation and expenditures; * * * * to electric light and power, telephone and telegraph business; to transportation by water, express business and street railways." The director is to prepare "such interrogatories as shall in his judgment be best adapted to elicit the information required under these subjects," and "may appoint special agents when necessary."

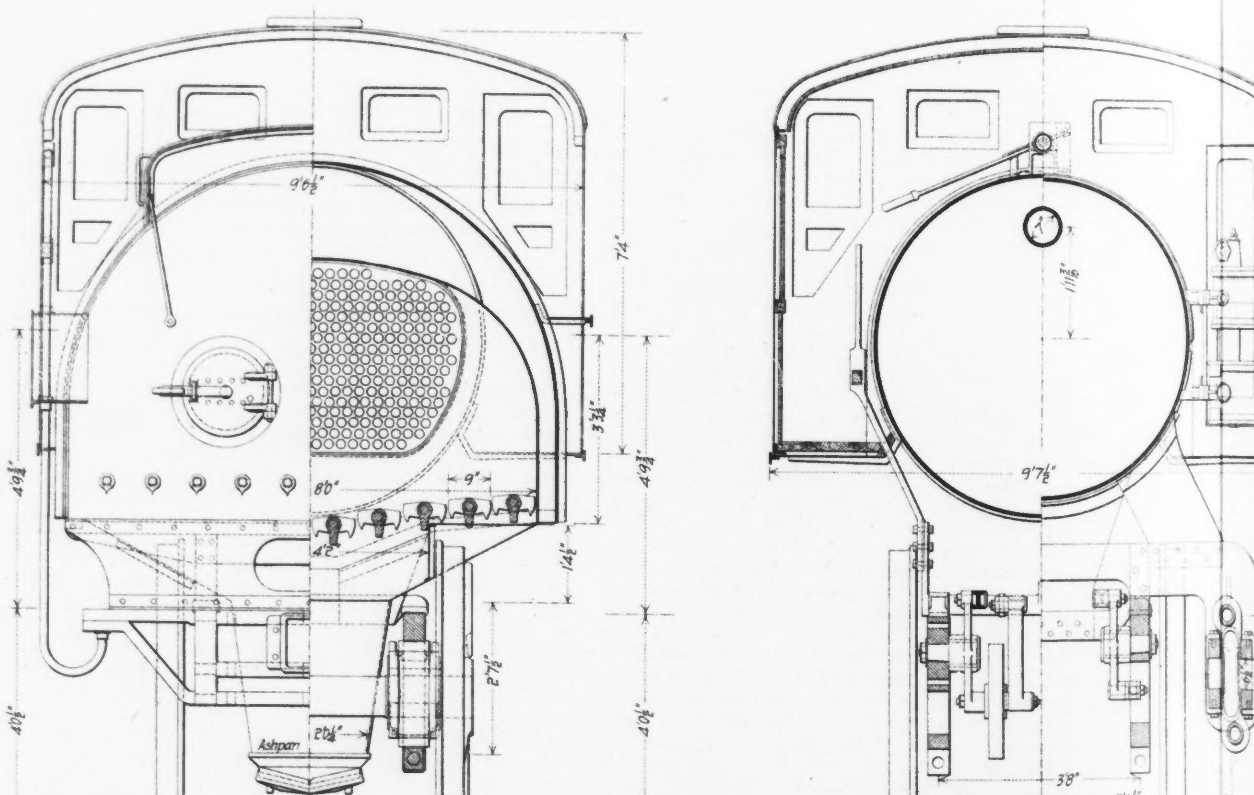
As the interpretation of these specifications is left with the director, and as the last census made "social statistics of cities" include water-works, street lighting and paving, sewers, police and fire departments, and included a wide range of financial information under equally general statutory authorization, it would seem as though the only limitations on the scope of the municipal inquiries for the next census would be the wishes of the director, the funds at his disposal, the inherent difficulties of the task and matters of general expediency.

The magnitude of the task depends upon the number of municipal works and municipalities included. The resolution adopted at Cape May apparently included all classes of municipal works, but did it mean all such works, regardless of the population of the place served? One of the classifications in the census of 1890 included "places" having populations of 4,000 or over, the number of which was then 905; but many places of less size have quite a variety of public works. In fact there were in 1890, as shown by "The Manual of American Water-Works" for 1891, as many places below as above 4,000 population that had water-works. The latest definite figures regarding water supply are given in the "Manual" for 1897, which, regardless of size, shows 3,196 works, located in 3,123 places, and supplying water for domestic and fire purposes in a total of 3,480 towns. If to this number there be added the places having a partial supply, or with unclassified works, the total is 3,942. Many of the works and the populations supplied are quite small, but nevertheless they are each and all of interest to students of municipal problems. Without the total the story would be far from complete, for the mere fact that so many small places are provided with public water supplies, speaks volumes for the concern shown in this country for comfort and convenience and the safety of life and property.

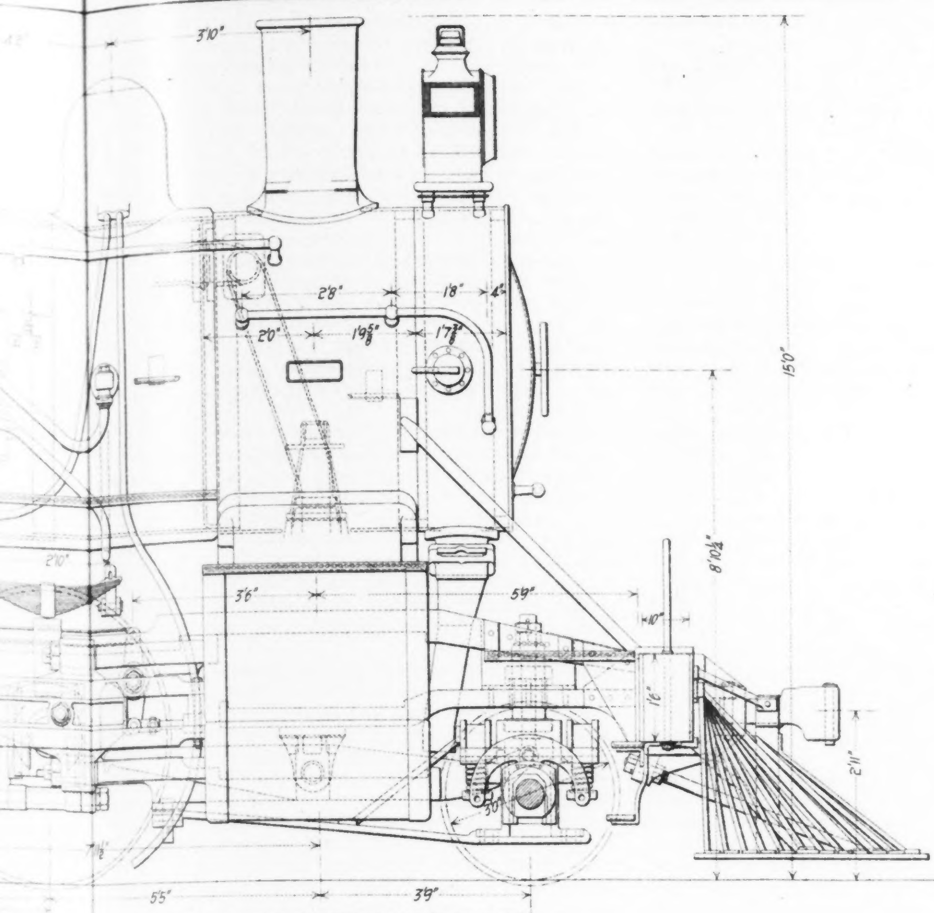
While it is true that water-works heads the list of distinctively municipal improvements (highways being common to country and city), yet wherever water-works are found some other municipal works may be expected. The necessity for water-works indicates such a concentration of population as will demand some sort of street lighting, while water for fire purposes requires apparatus for its utilization. Here the development of municipal works in places numbering a few hundred or a thousand or two of souls often comes to a standstill, but should two thousand places with even so meager a list of municipal works be neglected in a national inventory? The last census showed 3,715 places in the United States with populations of 1,000 or more, and we have seen that early in 1897 there were 3,480 places having a water supply for domestic and fire purposes. We have also seen that nearly every place with a complete water supply has at least the beginning of some other municipal enterprise. Allowing for growth in the number of waterworks in the last four years of the decade, and for increase in the other activities and the population

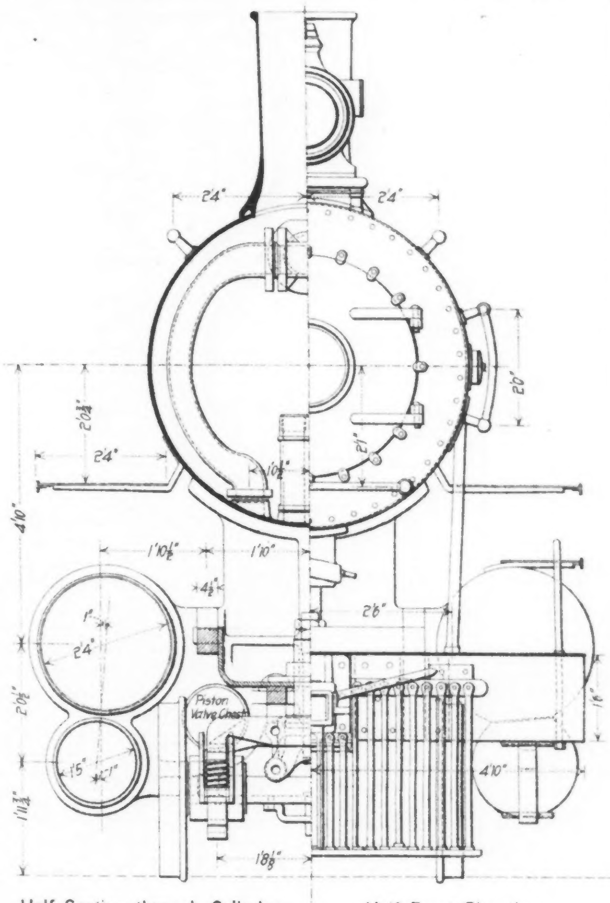


Sectional Elevation.

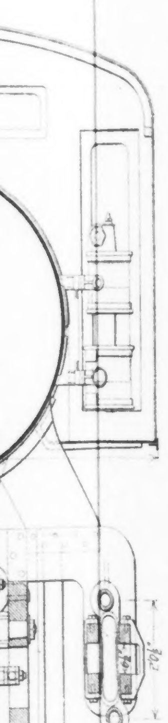


Half Rear Elevation. | Half Section through Firebox. | Half Section at Valve Gear. | Half Section through Guide





Half Section through Cylinders. Half Front Elevation.



ction through Guides.

FOUR-CYLINDER COMPOUND CONSOLIDATION LOCOMOTIVE
FOR HEAVY FREIGHT SERVICE;
LEHIGH VALLEY R. R.

Samuel Higgins, Superintendent of Motive Power.
F. F. Gaines, Mechanical Engineer.

Baldwin Locomotive Works, Builders.

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

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of the smaller places, it is seen that complete statistics of municipal works means the securing of returns under a few heads for several thousand places, with an increasing number of subjects for a smaller and smaller list of places, until the largest cities are reached. For the larger cities municipal works will include, not only waterworks, street lighting and fire departments, but also house lighting, street paving and cleaning, sewerage, improved means of disposal for both sewage and garbage, street railways, parks, cemeteries, public baths, gymnasia and playgrounds, ferries, river and harbor improvements, to say nothing of educational and art institutions, police, public charities and other municipal undertakings not always classed as, but more or less akin to municipal works. To be sure some of these things will be under private ownership and operation, but not the bulk of them, while those which are so owned are none the less the subject of constant and proper inquiry from many sources.

The above presentation is only the barest outline of the immense task before the census bureau if it is to secure complete statistics of municipal works, a task including not only the statistics of the nature and extent of the works named, but their cost, capital charges, operating expenses and revenue, as well. In addition, it is understood that municipal areas, population, vital statistics, taxation, indebtedness and other financial figures will be included in the census as a matter of course.

The spirit, if not the letter of the act providing for the twelfth census, seems designed to curtail rather than increase the lines of inquiry pursued in the last two censuses. The experience gained in collecting, digesting and publishing the enormous mass of information gathered in 1880 and 1890, give ample evidence that fewer things should be attempted in the hopes that more things should be well done.

It is a growing conviction with many that either a permanent census bureau must be established or the scope of the census materially decreased, while some believe that both plans would be wise, especially if some of the census inquiries were transferred bodily to permanent branches of the government. If the scope of the census were materially decreased, and the bureau made permanent, its primary object, ascertaining the population, might be attained even more promptly and accurately than now, and that once in five instead of once in ten years. We strongly urged, years ago, that once in ten years was too infrequent a count of people in a rapidly growing country like this, and we believe just as fully in the need of a permanent census bureau. To put it mildly, nothing can be more misleading than statistics and whether people are drawn into wrong paths through the maliciousness or ignorance of so-called statisticians matters little to those who are led astray. The first essential in collecting and compiling information of any sort is to have a proper conception of the needs of the people who are to use it and the second to present the data in an intelligible and readily available form. These essentials can be grasped only by trained statisticians, specialists in their several lines.

It is only by rare good fortune that such men can be induced to leave paying positions of reasonably fixed tenure for the uncertainties of a government census bureau, liable to be crippled for lack of funds or actually abolished before its work is done.

In regard to turning over some of the work of the census to existing government bureaus, it is well known that there are several bureaus which have previously collected or are now collecting and publishing statistics, such as the Interstate Commerce Commission, bureau of statistics and departments of agriculture and labor. It is very pertinent to this discussion to note that the bureau of labor was recently authorized by Congress to collect statistics of cities of 30,000 and upwards, while under its general powers it has been engaged for some time past in collecting information regarding public and private ownership of such municipal services as water-works and lighting plants. Might it not be well to extend the work of this department still further, giving it discretionary power to collect complete information regarding some one or more municipal works at a time until the whole range of them is covered, regardless of the size of cities, and perhaps allowing it to gather such statistics as it sees fit for places of 20,000, or somewhat less, instead of 30,000, as now?

We trust that the Board of Direction of the American Society of Civil Engineers will give the resolution adopted at Cape May the serious attention the subject deserves, and not only endeavor to secure the collection of as complete municipal statistics as is feasible, but make it a special point to determine just what information of this kind is most needed by engineers.

If in addition the matter could be taken up with care and expedition by the coming annual conventions of the New England Water-Works Association, League of American Municipalities, American Society of Municipal Improvement and the American Public Health Association, much good might result therefrom. The act providing for the next census states that the social statistics of cities, with other special inquiries, shall not be taken up until the regular schedules are completed, besides which this work is to be done by special agents; therefore the time available for the discussion and formulation of plans regarding municipal statistics is longer than appears at first thought.

In conclusion, while a complete exhibit of the nature and extent of our municipal attainments at the close of the nineteenth century would be of incalculable value, yet if it appears on investigation that this is not practicable, let all efforts be concentrated on some less ambitious but well-conceived scheme. We may reasonably hope that a few municipal enterprises may be presented with a fair degree of completeness for the whole country, and also all the undertakings of a group or certain groups of cities. Besides this is it too much to ask for a bare enumeration of the municipal works of every city, town, borough and village in the country? This could be presented in brief space and yet be of immense comparative value if no more than the following plan were carried out: Give the name, population and area of each place and devote one column to each class of municipal works, indicating in such columns the extent of the works in question, with a zero where no such works existed and an asterisk where the works were under private ownership. Thus there could be given first, because many other things would be compared with it, the length of all public streets in miles, then the miles of streets paved, sprinkled, cleaned, lighted, having water mains for domestic supply and fire protection, sanitary sewers, street railways and subways for electric wires. Next could be given that class of municipal enterprises best expressed by areas, such as parks, playgrounds, and cemeteries; and so on through the list. All this could be given in such small compass as to permit of two classifications, one alphabetically by States (disregarding counties) and another by populations of the cities included, greatest to least for the whole country. While it is very desirable that such a general exhibit as has been outlined should be supplemented by detailed special ones for lighting, transportation and other works yet even this one feature would be an object of legitimate pride and of immense benefit to the country at large.

LETTERS TO THE EDITOR.

Value of Reducing Curvature in Railway Location.

Sir: The writer was much interested in the extracts from the "Rules for Railway Location and Construction on the Northern Pacific Railway," published in your issue of April 20th, and greatly profited by a perusal of the same. It is seldom indeed that so much valuable matter is compressed into so small a space. In the course of the article there appears one statement in regard to which I should like to have some explanation. On page 252, 3d column, under the head of "Curvature," it is said: "The operating value of curvature, per degree, is assumed at $7 per daily train per annum."

I beg to ask if this statement was intentionally made, and is correct as it stands. Using the basis of computation given by Mr. McHenry, viz., 6% interest, for getting capitalized values, and assuming 8 daily trains, 4 "each way," this would give a capitalized value of $933.33⅓ per degree. Yours very truly,

Lacrosse, Va., June 28, 1899. C. H. Scott.

(We referred the above enquiry to Mr. McHenry, who sends us the following reply.—Ed.)

Sir: Replying to yours of the 12th regarding economic value of curvature, the assumed valuation of $7 per daily train per annum is already capitalized, and was taken from A. M. Wellington's "Economic Theory of Railway Location." Your letter finds me on a western trip, and as I have not my records with me I am unable to state whether this valuation is for a single or round trip. It is my impression that it is for the latter, in which case the valuation for four daily trains each way, as assumed by Mr. C. H. Scott, would be $28, instead of $933.33.

Yours truly,
E. H. McHenry,
Chief Engineer, Northern Pacific Ry.

St. Paul, Minn., July 17, 1899.

A New Test for Slag Cement—Adulteration of Portland Cement.

Sir: The suggestion, in answer to my communication, in your issue of July 13, that the presence of metallic iron in cement might be due to the abrasion of the metal surfaces between which the clinker is ground, was quite proper, and had been anticipated. No doubt there is iron in all cement from this cause. But the cause is, I think, quite inadequate to account for the following percentage:

I passed a common horseshoe magnet perhaps half a dozen times through four ounces of an American Portland cement until the "yield" seemed to decrease; but I stopped before all the iron was extracted. The amount extracted represented 1-1,000 part by weight. A slag cement was tested in the same way with a "yield" of iron of 1-300 part by weight. A German Portland cement gave a slight indication of iron (not weighed), and a reaction for phosphorus.

The American Portland cement referred to was one of 98% fineness on a No. 80 sieve and had a tensile strength neat of 750 lbs. in seven days and of 350 lbs. for a 2 to 1 sand mortar. I should hardly think that 1-1,000 part of iron in the cement could be due to the abrasion of machinery—otherwise the renewals would be rapid. Of this I am not informed.

A committee of the London Chamber of Commerce in 1898 reported on adulterations of Portland cement, and strongly reprehended the practice of slag adulteration. The method used by the manufacturer was the addition of slag to the clinker before grinding; and the committee noted adulterations of 30%. That part of the report would bear reprinting in your valuable journal.

No one objects to slag cement for certain uses. But with the growth of the industry in this country it is well to be on the lookout for adulterations of true Portland cement with slag. To touch on another point, certainly the practice of calling such slag cements Portland cements can lead to no good end. Yours,

July 17, 1899. Z.

Sir: Your correspondent "Z" suggests (Eng. News, July 13) inferentially that he did not consult a specialist. The chemist family is a large one and its members are, of course, incapable of handling every subject practically, although they will all undertake even an impossibility. If the gentleman in question had determined the amount of sulphur present he would have had data to go upon in considering the presence of slag in the cement. The magnet shows iron, but iron is equally present in either a Portland or a slag cement. This subject has recently been very thoroughly handled in a series of articles on cement in sea water, slag cement and slag bricks in the "Marine Record," of Cleveland, O., and I think it would repay "Z" to read these, as they will give him all the information he requires. Very truly,

July 17, 1899. T. Z.

Relief Map Construction.

Sir: I was very much interested in the article on "Relief Map Construction,' by Mr. Frank G. White, in your issue of July 13, and a method and material that I have used in constructing models may be of interest, as it differs somewhat from the practices that have come under my observation.

Having a contour map of the locality to be modeled and the vertical scale determined upon, this contour map is drawn on the base itself, and divided into sections. Wire finishing nails are then driven in the base of the map at all of the main control points, to the exact height as indicated by the contours. All streams, roads and water courses are then marked, wherever they change direction, in the same manner. The number of these control points is determined by the modeler. Having many points will reduce the chances of error, and also restrain any desire to artistic license.

I have experienced all the difficulties and disappointments connected with the use of wood and linen pulp, used separately, in combination, and in combination with starch and calcined plaster, and other materials generally used for this purpose. As a material for filling, I have obtained excellent results from the use of granulated cork (the kind used for packing Malaga grapes) thoroughly covered with a solution of fish or other strong glue. This is molded roughly around the nails as a foundation for the finer finishing material, and is then allowed to dry. Another coat of finer granulated cork (cork run dry through the household rotary meat-cutter was the kind I used) was spread over the first layer, to fill up the interstices and to obtain a smoother finish. This was also allowed to dry, and with the contour map before me, which was also divided like the relief map into sections, a finishing coat of plastic material, composed of three parts wood pulp, one part linen pulp, two parts calcined plaster and one part of corn starch, with sufficient fish glue to make the same adhere, was applied, being pressed and worked into all the interstices between the cork filling. Taking it in detail, all the sinuosities of the surface can be reproduced.

By careful manipulation, there was very little shrinkage of this material when dry, as the last coat was worked rather stiff. The cork base is light and sufficiently strong, and it is not necessary to use great care in placing it in position, although it is desirable to use as little pulp in finishing as possible, for the reasons stated. This gives a smooth surface on which to paint the culture.

The nails used to mark the control points were pulled out when the modeling was finished, and the holes were filled with some of the finishing composition.

A map now on hand, modeled partially in cork composition filling, and partially in material used for the finishing coat as described, shows clearly the value of using cork as a filler, as when dry it is very strong and will stand considerable rough handling without damage, will not absorb moisture like pulp, and is very light.

I had an experience with one large map which was modeled in paper pulp that was very harrowing, as a great deal of time was spent on it. The surface detail showing the culture was all worked out in topographic conventional signs, in colored indelible inks, which, after six or eight months, were all absorbed by the material, although the map had been carefully and thoroughly sized before inks were applied. As the map had also been carefully varnished after it was completed, nothing could be done to arrest the disappearing colors.

E. E. Betts,
War Department, Chickamauga and Chattanooga National Park Commission.
Chattanooga, Tenn., July 15, 1899.

Notes and Queries

D. L. E. asks if anyone knows of any apparatus by which it is possible to take continuous blue prints in one piece, say up to 30 or 40 ft. long, and if it can be used successfully, and where it is made.

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

By an oversight in the make-up of our last issue two cuts were omitted from the article describing the use of scrapers to clean cast-iron water mains at St. John, N. B. The cuts are presented herewith. Fig. 1 is a view of the scraper and Fig. 2 gives details of the hatch boxes provided to admit the scrapers to the main.

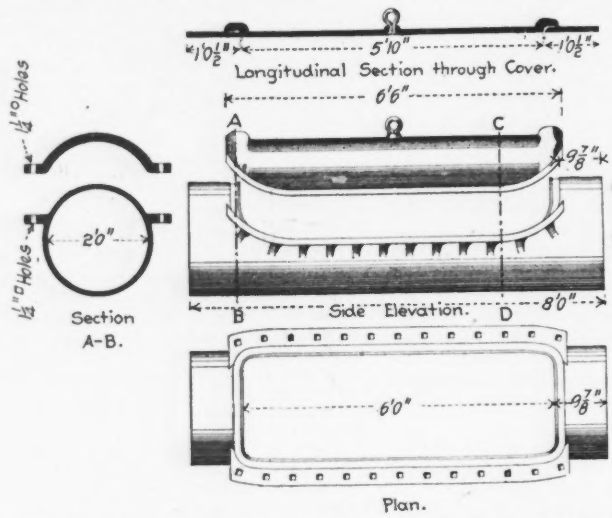


FIG. 2.—CAST-IRON HATCH BOX FOR ADMITTING SCRAPER TO WATER MAIN.
Wm. Murdoch, Engineer of Water-Works.

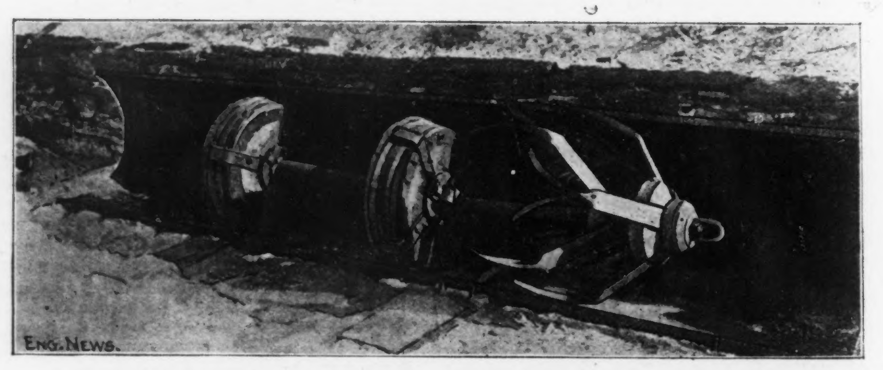


FIG. 1.—VIEW OF PIPE SCRAPER USED IN 1898 AT ST. JOHN, N. B.

NOTES FROM CITY ENGINEERS' AND OTHER MUNICIPAL REPORTS.

The last annual address of Mr. Josiah Quincy, Mayor of Boston, deserves mention as being one of the most comprehensive and thorough surveys of the affairs of a municipality that has ever come to our attention. Lack of space forbids taking up the great variety of subjects treated, but little or nothing has escaped Mr. Quincy. He deserves great credit for realizing the value and necessity of the services of trained technical men in the administration of cities.

The last report of the Boston Transit Commission reviews the work done under the direction of Mr. Howard Carson, M. Am. Soc. C. E., Chief engineer, in bringing the subway to completion. It contains many fine illustrations.

The Metropolitan sewerage district of Massachusetts now includes part of the city of Boston, the whole of 13 other municipalities and parts of 8 others. The total area embraced is 164 sq. miles, and the combined length of sewers controlled by the commission is 69 miles. There are three systems of outfall sewers, with two points of outlet into tide water, the sewage receiving no treatment. Studies of the effect of this sewage upon the water receiving it were given, with a map, in our issue of March 16, 1899. The total cost of the sewers, pumping stations and accessories to Sept. 30, 1898, was $6,727,432. Mr. Wm. M. Brown, Jr., M. Am. Soc. C. E., is Chief Engineer and Superintendent of the Commission.

The last report of Mr. L. M. Hastings, City Engineer of Cambridge, contains a folding sheet showing 19 interesting sections of sewers on special foundations. The sewers range in size from 10-in. pipe to 34 x 36-in. concrete and brick; some are of wood, circular and rectangular, and nearly all rest on pile and timber foundations. The same report contains daily rainfall records for the year ending Dec. 1, 1898, at three stations connected with the city water-works and at the Harvard Observatory. The variations at the different stations are notable for some months in the year, but the totals for the year vary less than an inch.

The city of Fitchhurg, Mass., has lost about $5,000 by taking contracts for building roads under the State Highway Act, instead of allowing the Massachusetts Highway Commission to let the work to private contractors. Of this sum $1,000 was lost last year on 3,200 ft. of road, having a bottom course of local granite and upper courses of trap rock from Waltham. The city engineer of Fitchburg, David A. Hartwell, states in his last report that undoubtedly the work would have been done as well by the state as by the city, and that "the reasons for this loss are evident to any careful observer of the work," and makes further remarks from which it may be inferred that it was due to poor management. Against the character of the work nothing is said; in fact it is pronounced satisfactory.

A No. 40 Rife hydraulic ram was installed at Newton, Mass., in 1898, to lift water to some ponds in a cemetery. The cemetery is owned by a company, and it was claimed that the construction of a 20 x 30-in. brick and concrete sewer, with a 15-in. underdrain 6½ ft. below the bottom of and 525 ft. away from the lower pond, lowered the water in the ponds. The ram is driven by water brought from the underdrain through 35 ft. of 4-in. pipe. The head on the ram is 6.1 ft., and the water is raised 19 ft. above the ram through 1,708 ft. of 1½-in. pipe, the delivery being 10 gallons per min. Mr. Henry D. Woods, M. Am. Soc. C. E., is City Engineer of Newton.

During 1898 a daily average of 17,700,000 gallons of sewage was treated by the chemical precipitation works at Worcester, Mass., using 1,073 lbs. of lime per 1,000,000 gallons of sewage. Analyses show that the condition of the water in the Blackstone River, below the works, is much better than in 1897., and still better than in 1893. Mr. Harrison P. Eddy is Superintendent of Sewers.

The latest report of Mr. Geo. A. Carpenter, City Engineer of Pawtucket, R. I., contains two views of sewage filter beds after a snow fall, showing the advantages of furrowing the beds in the fall, in order that the sewage may circulate beneath the snow.

The municipal electric lighting plant at South Norwalk, Conn., has been used for street lighting for six years, and has been extended to supply commercial lighting as well. The Board of Electrical Commissioners issues an interesting yearly report. It states that the cost of street lighting during the past two years, including capital charges, is less than the amount "paid by any city to any electric light company in this country for lighting service similar to that of this city." The actual figures were a little over 17 cts. per 1,400 c. p.-lamp per night for 309 nights in 1898 and 308 in 1897. The lamps do not burn all night, and the number of hours lighted is not given. Mr.

Albert E. Winchester is general superintendent of the lighting system.

Recent specifications for paving a street with brick at Albany, N. Y., provided that during the progress of the work the city engineer should "weigh not less than 50 of the bricks of apparent average quality and appearance" and file a certificate of the result. During the ten-year guarantee maintenance period, the proper officer shall take up and reweigh 50 brick from time to time, and whenever a 15% loss of weight is found any bricks on the street must be replaced with bricks as nearly as possible of the size and quality of the original. The contract price was $2.10 per sq. yd., laid on 8 ins. of concrete, and 25% of the price is retained during the guarantee period. The report contains a large amount of information regarding the public works of the city and a table giving the results of three tests of paving bricks made at the laboratory of Lathbury & Spackman, Philadelphia, in accordance with the standard of the National Brick Manufacturers' Association.

The first annual report of the Board of Public Works of Geneva, N. Y., deserves commendation for its careful review of the work of the year and the needs of the future. Many details of construction and maintenance of sewers, water-works and paving are given, illustrated by half-tone and line engravings. For macadam roads on clay, Mr. Gomer Jones, Engineer-in-Charge of Streets, adopted the following plan: 2 ins. of stone was forced into the clay soil wherever possible "and sorted and packed until this sub-grade was made uniform and solid from one end to the other." The object of this was to ensure a uniformly curved foundation for the macadam proper, or, in other words, to prevent the clay from working up into the bed of the macadam or the latter from working down into the clay. On top of this foundation 11 ins. of broken stone was placed, the first 6 ins. being 2-in. stone from the adjacent quarries at Waterloo, N. Y., and the top 5 ins. being Hudson River trap rock. The cost of the Waterloo stone was $1.875 and of the Hudson stone $2.50, spread, in each case. Telford was not used, because it was believed that the clay would work up between the large voids of the foundation. Mr. E. Seybolt is Superintendent of Public Works at Geneva.

A curious break in a cement sidewalk adjoining the Congressional Library at Washington, D. C., is noted in the Report on the Operations of the Engineer Department of the District of Columbia for 1897-8. The walk was a new one and the break was due to the expansion of the material composing it. Two blocks were thrown several feet into the air, with a noise like the report of a gun. Other breaks occurred during the hot, dry season, but without much displacement of the material. During the year mentioned above 62,796 sq. yds. of cement walk were laid, at an average cost of 89 cts. per sq. yd. The walks were 5 ins. thick, without a frost base. During 1898-9 the contract price for cement walks is 98 cts. without and $1.18 with a frost base. The report shows the cost per sq. yd. per year of repairing asphalt paving after the expiration of the five-year guarantees, the cost being given by years and some of the paving having been down since 1874. The report also contains an account of investigations by Mr. A. W. Dow, Inspector of Asphalts and Cements, on the use of petroleum residuum as a softening agent, or flux, for asphalt, and described an apparatus, devised by Mr. Dow, for determining the relative viscosity of asphalts and allied bodies. On the first subject the conclusions given are as follows:

Judging from the physical properties of the petroleum residuum and its chemical relation to asphalt bitumen, it is not a desirable flux, but it should not be judged too strongly in the absence of physical tests carried on on the asphalt cement made with it. Such an investigation is in progress, comparing asphalt cement made with petroleum residuum and several asphalt oils as fluxes with Trinidad asphalt, along with several other well-known asphalt cements.

The last report of Mr. A. L. White, City Engineer of Wheeling, W. Va., contains some information regarding the method employed in a number of cities to raise money for sewers and street work. The general rule is to assess at least a part of the cost of the work upon the property benefited, a frontage basis being commonly employed.

The last report of Mr. F. W. Cappelen, M. Am. Soc. C. E., City Engineer of Minneapolis, contains some interesting information on brick and asphalt paving work done in 1898. Two streets were paved with brick by the city force. The brick were bought from the Purington Brick Co., of Galesburg, Ill., at $15.50 per 1,000, with a guarantee of 57 bricks per sq. yd. and a 10-year guarantee on the wearing quality of the brick. The bidders were requested to state whether they preferred sand or asphalt fillers. Each of the four bidders preferred sand and one would give only a five-year guarantee on asphalt filler. The brick were laid (judging from the contract) on 6 ins. of concrete. Utica cement cost 82 cts. per bbl. in jute sacks; sand, 34½ cts. per cu. yd.; and crushed rock, from $1.15 to $1.30 per cu. yd. Teams were paid $3.50 a day; labor, $1.75 and $2, the latter for a few pavers. The average cost of the paving was $1.61 per sq. yd. The sand for the filler was heated to 150 to 200° F., swept into the joints until flush, and then the pavement was rolled until it became firm. A few days later sand to a depth of about ½-in. was spread over the surface and left there.

In a report on the Capitol Hill Sewer District No. 1, for Denver, Colo., Mr. Harvey C. Lowrie, Engineer of the Board of Public Works, states that the conditions governing the capacity of the sewers are peculiar. The annual rainfall at Denver is only 15 ins., and the area in question already has sanitary sewers. On May 27, 1898, rain fell for 15 minutes at the rate of 4.56 ins. per hour, but this was almost double any other rate recorded in 26 years. Only five times in the last 26 years has the rate of rainfall exceeded 1.8 ins. per hour. The latter figure was therefore assumed as the maximum rainfall in designing the system. The Burkli-Zeigler formula was used for computing the amount of water reaching the sewers, as follows:

$$Q = 0.65 \text{ (or } 0.53) \times 1.8 \sqrt[4]{\frac{\text{slope}}{\text{area}}}.$$

The factor 0.65 is for the section apparently destined to be most closely built up, while 0.53 is used for the remaining area.

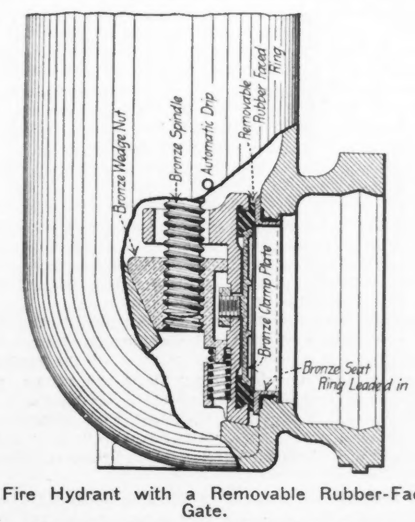
According to the last report of Mr. M. K. Miller, Superintendent of Streets at Oakland, Cal., a rigid system of compelling the restoration of street surfaces disturbed by private individuals or corporations is enforced in that city. An ordinance passed on June 21, 1895, provides that:

All persons excavating in the streets are required to deposit $10 for each 30 sq. ft. of surface disturbed, or in lieu thereof, to file with the Board of Public Works a general bond, said deposit or bond being held by the Board as security that the person will comply with the terms of the ordinance and repair any place disturbed, upon notice, within five days after the receipt of said notice for a period of one year.

Practically all these street excavations are made under a general bond. The chief deputy of the street department is instructed to examine the site of all street excavations personally about ten days after they are made. If places are found needing attention, notices to that effect are sent to the proper parties at once. In addition, about every two or three months a man is specially employed to examine every street in the city for ridges and depressions, note each one found and locate the responsibility for it. Proper notices are sent for each deficiency found and re-inspections are made to determine whether the notices have been complied with. The report states that during the last two or three years not less than 10,000 deficiencies have been repaired as a result of this system, more than 5,000 by the Oakland Water Co. alone. There are some hundreds of other cities in the country that might adopt and enforce this system with great advantage.

The report contains an interesting account of the use of redwood block paving, with an asphalt carpeting, or wearing surface, which we abstracted last week. Mr. Miller has also embodied much other matter in his report of great interest and practical value to street superintendents and city engineers. In fact, a large part of the report would be well worth reprinting if space could be found for it. As this is impracticable, we suggest that all those concerned with street construction and maintenance would do well to send for a copy of the report, but we cannot promise that enough copies were printed to meet the demand. In case the edition is quite limited, very likely those enclosing stamps will be served first. This hint is thrown out because we were recently informed that of some scores of applicants for a copy of a blank form recently noticed in Engineering News only one thought to enclose a stamp for postage.

A FIRE HYDRANT WITH A REMOVABLE RUBBER-FACED GATE.



A Fire Hydrant with a Removable Rubber-Faced Gate.
The Chapman Valve Manufacturing Co., Indian Orchard, Mass.

A desirable feature of fire hydrants is the possibility of readily removing the working parts without disturbance to the street. This is effected by so designing the hydrant that the working parts may be lifted out, leaving the case in position. A gate hydrant of this sort has been placed on the market recently by the Chapman Valve Manufacturing Co., of Indian Orchard, Mass. The working parts of this hydrant are shown by the accompanying illustration. The gate or plug has a vertical face, faced with a heavy renewable ring of rubber. The ring is held in place by a bronze clamp plate and nut and seats against a bronze ring leaded in. The gate is forced down by the spindle rod, without touching the seat ring until the bottom stop is reached, when the wedge nut at the rear forces the gate horizontally against the ring seat, the rubber making a tight joint. In opening, the process is reversed, thus guarding against sliding friction between the rubber face and the bronze ring seat. The drip is on a level with the water in the main, is bushed with brass and is always open when the gate is closed and closed when the gate is open. The other features of the hydrant, not shown in the illustration, give evidence of good design.

REPORT OF THE SPECIAL COUNSELS' INVESTIGATION OF THE NEW YORK STATE CANAL IMPROVEMENT.

No evidence upon which criminal prosecution may be based can be found by the special counsels' commission, which was appointed some time ago to examine the testimony secured by the Canal Improvement Investigating Commission in regard to the improvements carried on under the $9,000,000 appropriation for enlarging the Erie, Oswego and Champlain Canals in the state of New York. The report of the original investigating commission was published in Engineering News of Aug. 11, 1898. As the result of this report Judge Edwin Countryman, of New York city, was appointed by former Governor Black to examine the evidence and report whether civil or criminal proceedings should be instituted against any persons or public officials by reason of acts in connection with the canal work. The substance of Judge Countryman's report (Eng. News, Dec. 8, 1898) was that prosecutions could lie against both the Superintendent of Public Works and the State Engineer. The Attorney-General, to whom this report was referred by Governor Black, with instructions to institute proceedings, was, however, not satisfied that he could secure conviction on either the evidence of the Investigating Commission or on anything contained in Judge Countryman's report. He, therefore, appointed Benj. J Shove, of Syracuse, as special counsel to go over the testimony again, and later Governor Roosevelt appointed Messrs. Wallace MacFarlane and Austin G. Fox, of New York city, to work with Mr. Shove. The report of these three gentlemen, which has just been issued, is confined strictly to a careful examination of the testimony and the report of the Canal Investigating Commission and of Judge Countryman, and of all the papers and contracts connected with the canal improvement work, including a personal examination of a number of the engineers who had charge of parts of the work. Whether the work which has actually been done is of good quality and in accordance with the contracts they did not investigate, but confined their investigation to the expenditure of the $9,000,000 appropriated for the general canal improvement work. The following abstract of the conclusions of the report explains the position of the commission quite clearly:

The objects of the most severe criticism by the Canal Investigating Commission were: The lack of correspondence between the computations made from preliminary surveys as stated in the bidding sheets and the work actually done; by the failure to prepare the specifications in time to inform the engineers engaged in the preliminary survey what would be the definitions of rock and embankment; by the futile attempt to bring the work, which the preliminary survey showed would be desirable, more nearly within the authorized expenditure of $9,000,000; by cutting out large quantities of the proposed work, especially of slope and vertical wall; the classification of earth as rock; the allowance of an embankment price in addition to the price for excavation where materials were hauled more than 1,000 ft.; the excessive number of special agreements for extra work not included in the contracts and made without public letting, increasing the expense. We have decided not to institute criminal proceedings. If, as alleged, the State Engineer and his principal assistants prepared bidding sheets without sufficiently considering the form of the specifications, if the specifications were loosely drawn, if the bidding sheets disclosed but imperfectly the quantity and nature of the work that would actually be required, if the Superintendent of Public Works awarded contracts on such inadequate estimates, if methods of classification and measurement were followed which in the judgment of skilled engineers were loose and extravagant, and even if a disposition was shown to exercise discretionary powers persistently in favor of the contractors at the expense of the State, yet it does not necessarily follow that crime has been committed. Such conduct undoubtedly justifies severe criticism, and may properly subject the public officials concerned to removal from office and render them the objects of just public indignation. But to justify a criminal prosecution something more is required than proof of hasty calculations, ignorance of the conditions that would be met on the work and errors of judgment in drawing the specifications, while in respect to the exercise of discretionary powers (in the important subject of rock and earth classification) it is obvious that no criminal prosecution is really practicable without something more than an opinion, however authoritative, that the discretion was not wisely or properly exercised. There should be reasonably clear proof that in the transaction made the subject of the charge the conduct of the accused was determined by some dishonest motive, or at least that the accused, with full knowledge of the facts, deliberately neglected to perform some duty in the premises enjoined upon him by law, or disobeyed the positive commands of some law relating to his official duties. If some of the methods adopted in preparing the bidding sheets and some of the provisions of the specifications appear in the light of subsequent events to have been ill-judged, such mistakes do not necessarily constitute "wilful neglect" or "wilful omission" to perform such duties, which by our statutes is made a criminal offence.

Our decision to institute no criminal prosecutions on this evidence does not mean that in our opinion the officials charged with carrying out the great work of improving the canals have done their duty. The discretionary powers vested in the Superintendent of Public Works and the engineers by the contracts and statutes, pursuant to which the work was done, were unduly great and have been abused. The acts which have been most severely criticised will be found to be exercises of discretionary powers. Classifying hardpan, locating spoil banks and borrow pits, thus determining embankment allowances, making special agreements for alleged "changes of plan," all involved the exercise of discretion. In work of such magnitude the most carefully drawn statute must confide much discretion to somebody, and if the officials in whom the confidence is reposed are without fidelity to their duties, they can be guilty of much misconduct which does not amount to a violation of criminal law. While the prosecution of a public official on a charge of criminal violation of his duty is necessary where it is clear that crime has been committed by him, yet it should not be undertaken on rumor or suspicion or inadequate evidence in deference to an excited public opinion. If it is so undertaken, experience has shown again and again that the proceedings will not result in punishing the suspected.

An important lesson to be learned from the unsatisfactory results of the attempt to improve the canals is that in future work of this description the powers of the State Engineer and of the Superintendent of Public Works should be greatly restricted. We refer only to special work, involving large expenditures, and not at all to the work done under the regular annual appropriations, which must necessarily be performed under more flexible regulations. A statute authorizing work so extensive as this canal improvement should, in unmistakable terms, forbid the State Engineer or any State officer from making allowances for items of work not included in the contract, and from authorizing work to be done on terms of payment other than those permitted by the contract, except in the case of necessary extra work. This would put an end to the pernicious system of force accounts. The ordering of extra work, however, should also be strictly guarded. Extra work should not only be strictly forbidden, unless performed upon written orders of the State Engineer at agreed prices, with the approval of the Canal Board obtained beforehand, but also, if the total aggregate cost of the extra work contemplated exceeds a sum to be fixed by the statute, say $1,000, the statute should provide that all such work exceeding that limit in aggregate cost should be done by contract let to the lowest bidder after public advertisement for bids. The statute should also contain a provision that neither the State nor any department or officer thereof shall be precluded or estopped by any return or certificate made or given by any engineer, inspector, or officer, or by any appointee of the State Engineer or the Superintendent of Public Works, from at any time showing the true and correct quantity and character of the work done and the materials furnished by the contractor, or from contesting the amount due. The form of the contract in use should, of course, be made to conform to the statute and will bear careful revision in many respects. Such a statute will not prevent abuse if the officials in charge of the work are unfaithful, but when the abuses have been discovered the statute will stand by the State and, if apt penalties are provided for disobedience, responsibility can be fixed and punishment inflicted. A conspicuous illustration of the value of such a statute is found in the result of the litigation which arose over the construction of the new Croton Aqueduct in the city of New York, under chapter 400 of the Laws of 1883. Probably the statutory restrictions, in certain sections of that act, and the strict provisions of the contracts made in accordance therewith, saved the city a very large amount of money, which it would otherwise have been compelled to pay without having received any adequate return.

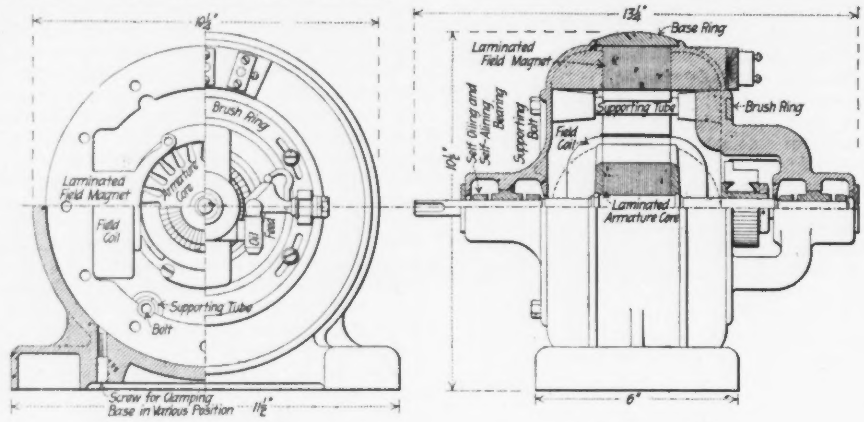


FIG. 1.—DETAILS OF ¼-HP. ENCLOSED ELECTRIC MOTOR. B. F. Sturtevant Co., Boston, Mass., Makers.

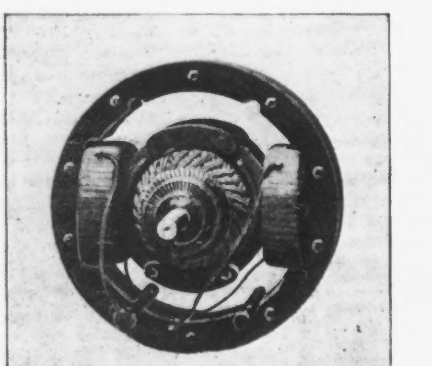


Fig. 2.—View Showing Removable Field Ring Pole Pieces and Armature.

A SMALL ENCLOSED ELECTRIC MOTOR FOR FAN OR POWER PURPOSES.

We illustrate herewith an interesting little electric motor of the bi-polar enclosed type, intended to be directly connected to a propeller ventilating fan or to operate as an independent motor for power purposes. The novel feature of the motor is the laminated field ring which is built up of circular iron stampings provided with proper projections to form the field cores and pole pieces, so that when they are assembled and bolted together they form a solid ring with the pole pieces complete, Fig. 2.

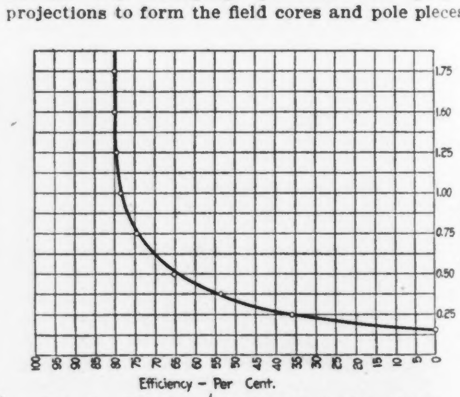


Fig. 3.—Efficiency Curve for ¼-HP. Motor.

This ring is then slipped in a cast-iron frame and two cup-shaped end pieces containing the armature shaft bearings are bolted against opposite sides of this frame. Two forms of frames are used, a three armed spider for fans, and one with a flat base for power purposes. The end plates are clamped in place by four bolts, which also secure the field ring in its proper position relative to the armature. Fig. 2 is a view of the complete field with coils and armature in place, ready to be slipped into either frame as described.

The machine complete, as shown in Fig. 1, weighs 60 lbs., and is rated at ¼ HP. with a pressure of 500 volts and a speed of 1,500 revolutions per minute. The brush holders are mounted on a flat ring, which fits into a groove in the face of the bearing plate, and can be slid around to adjust the position of the brushes.

The motor is capable of continuous operation for 10 hours, with a temperature rise not exceeding 30° F. From the efficiency curve, Fig. 3, it will be seen that the efficiency from about full load to 25% overload, the usual condition under which small loads operate, is 80%, an excellent figure for such a small motor. It is claimed by the makers that an excess load of 75% above the rated capacity can be carried by the motor without sparking or overheating.

The fan used for ventilating purposes is of peculiar design, and is the result of an extended series of experiments with a variety of types of fans and shapes of blade. It belongs to the propeller class, and has eight blades firmly attached to a central spider and secured at their outer edge to a substantial ring. The form of the blade is such that air is picked up at a low velocity and accelerated to its maximum velocity with the least amount of slip. To further increase the efficiency of the fan, a flaring or conoidal inlet ring is added to reduce the loss due to friction of the entering air.

The motor and fan are recent productions of the B. F. Sturtevant Co., Boston, Mass., to whom we are indebted for the material from which this description has been prepared.

60-TON HEISLER GEARED LOCOMOTIVE; McCLOUD RIVER R. R., NORTHERN CALIFORNIA.

In our issue of Dec. 9, 1897, we discussed the use of geared locomotives, and illustrated and described the Heisler system of geared locomotives. We are now able to give particulars of a 60-ton engine of this type, having three driving trucks, or twelve driving wheels in all, which has been in regular service for some time. The engine has two cylinders, inclined inward and downward (transversely) at an angle of 45°, and driving a crank shaft on the longitudinal center line of the engine. Intermediate shafts, with universal couplings, connect the ends of the crank shaft with a driving shaft on each truck. One axle of each truck is driven by an enclosed bevel gear (running in an oil chamber), and the other axle is driven by coupling rods. A special feature of the gearing, as described in our former article, is that it is supported from the axle and not from the truck frame, thus maintaining the gear in proper mesh, and relieving the truck frame from the twisting strains due to the gearing.*

The 60-ton engine in question has three driving trucks, one under the forward end of the boiler barrel, one under the firebox (which is above the frames), and the third under the tender. The cylinders are just forward of the firebox. It was built for the McCloud River R. R., in Siskiyou county, Cal., which is about 20 miles long and is at the base of Mount Shasta. On account of the danger from forest fires during the long dry season, no timber trestles or bridges were used, but earth embankments were made by means of water jets, a system which has also been employed extensively on the Northern Pacific R. R. The jets of water directed against the hillside bring down quantities of material which is retained at the desired site by means of parallel dams until the solid matter has settled, the waste water escaping at an overflow.

From McCloud the road rises by grades of 2 and 3% for about 1½ miles, and then has about six miles of an unbroken 4% grade to the summit, where the line is level for about two miles. Beyond this, the line descends by grades of 0 to 4% to Upton, on the Southern Pacific Ry. The maximum curves are of 383 ft. radius, or 15°, and all the 4% grades are compensated for curves. This forms the main line, but the branches or spurs to sawmills and into the forest include curves of 190 ft. radius. The track is of standard gage. The road is only operated during the summer, being buried in snow during the winter. It was located and built under the direction of Mr. H. Cooley, the Chief Engineer and General Superintendent, who was formerly Superintendent of the Mt. Shasta Division of the Southern Pacific Ry.

The railway's traffic is chiefly lumber. It takes across the mountain to Upton the output of a sawmill at McCloud with a daily capacity of 150,000 ft., and of several smaller mills in the neighborhood.

The equipment includes three locomotives and 52 cars. The cars are ordinary flat cars fitted with air brakes, and are loaded with 18,000 to 22,000 ft. of green lumber cut from heavy logs, some of the logs being so heavy that they sink in the millpond.

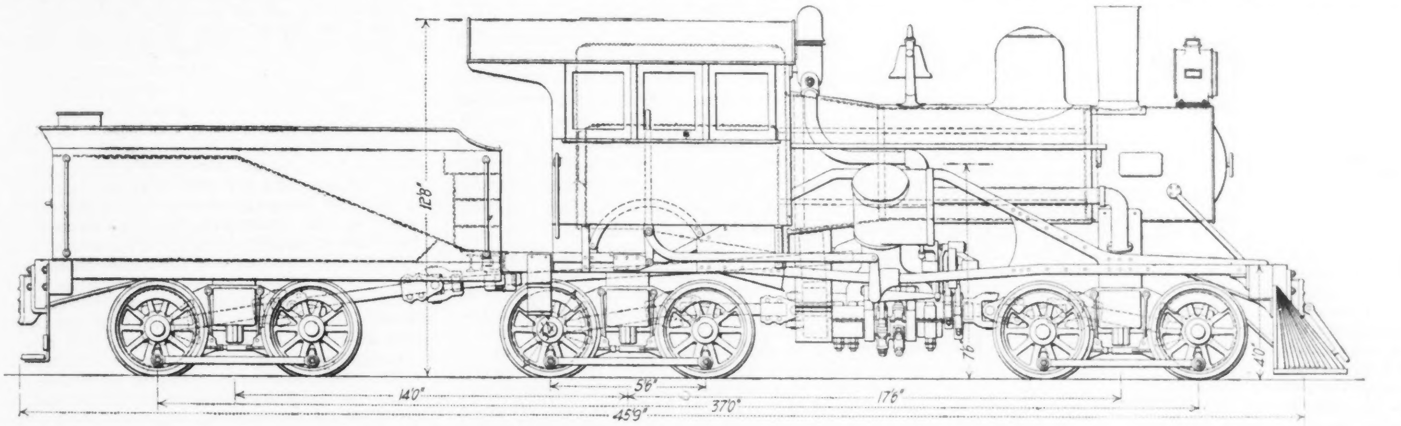
The locomotives include two ordinary direct-connected engines and the Heisler geared locomotive herewith illustrated, the latter working both on the main line and on the rough track of the spurs, which are run into the forest to bring out the logs. A 60-ton mogul locomotive, rented from the Southern Pacific Ry., worked in regular service with the Heisler engine, hauling trains from McCloud to the summit. The former would haul four loaded cars at an average speed of six miles per hour, as a regular maximum load on dry rails on the 4% grade. The Heisler engine would haul six loaded cars at about the same speed, but with a lower fuel consumption, and it would haul this same load when the rails were wet, the mogul then being able to take only three cars, owing to the slipping of the driving wheels. Its maximum speed was 15 miles per hour, empty, or 5 to 7 miles per hour with a train. A direct-connected engine was especially designed for this road, having six coupled wheels and a pony-truck at each end, to make it ride better than the mogul. It had only the same capacity of load and speed, however, as the mogul engine, and with wet rails its load was often limited to two cars.

The speed in descending the grades is limited to 12 miles per hour, by the Superintendent's orders, for though speeds of 15 to 20 miles per hour were attained the practice was considered dangerous.

All the engines burn wood, but the Heisler engine has a straight smokestack, the spark-arresting device being in the extension smokebox. The main frames and the truck frames are of iron and steel, no wood being used except for the bumper beams. The gears are steel castings having a minimum tensile strength of 55,000 lbs. per sq. in., and are enclosed in steel cases which can be readily removed to allow of the gear wheels being inspected and renewed. These cases form the oil chambers in which the gears run. A triple-compound steam brake and a water brake are fitted to the engine, with brakeshoes on all the wheels, the brake rigging being so arranged that the brakeshoes will neither bind nor fail to act on curves. The Westinghouse air brake is provided for the train, and there is an auxiliary hand brake for the tender truck.

The Heisler engine was built by the Stearns Mfg. Co., of Erie, Pa., to the designs of Mr. Charles Heisler, Consulting Engineer, of Erie, Pa., to whom we are indebted for plans and particulars. Its general dimensions are as follows:

Driving wheels (12), diameter	3 ft. 4 ins.
Tires, width of tread, 4⅜ ins.; total width	5½ "
Axles (steel), diameter	6 "
Wheelbase of each driving truck	5 " 6 "
Wheelbase, total	37 " 0 "
Length over all	45 " 9 "
Weight, all on drivers (tender tank empty)	60 tons.
Cylinders (2)	18 × 15 ins.
Crank shaft (steel), diameter	7 "
Pinion shafts (steel), "	5½ "
Boiler, type	Wagon top.
" diameter of barrel	4 ft. 0 ins.
" thickness of plates	7-16 and ½-in.
" height, rail to center line	7 ft. 11 ins.
" working pressure	170 lbs.
Firebox, inside	6 ft. 9½ ins. × 4 ft. 0 ins.
" depth	3 " 9½ "
" side, back and crown plates	5-16-in.
" tube plate	⅜-in.
" crown stays (screwed into shell and crown plates)	1⅛ ins.
" grate	Rocking and dumping.
" staybolts, diameter, 1 in.; pitch, not over 4 ins.	
" water spaces	3 ins. at bottom to 4 ins. at top.
Tubes (188), diameter	2 ins.
" length	11 ft. 0 "
Tender tank, capacity	2,800 gallons.
Height, rail to top of smokestack	12 ft. 8 ins.



TWELVE-WHEEL GEARED LOCOMOTIVE; McCLOUD RIVER R. R.
Charles L. Heisler, Designer. Stearns Mfg. Co., Builders.

*The "Climax" and "Shay" types of geared locomotives have been described and illustrated in our issues of Dec., 1897, and March 9, 1899.

GAS ENGINES AS MOTIVE POWER IN ENGINEERING WORKS.

By A. R. Bellamy, M. Inst. M. E.

It is not necessary to discourse upon the merits of gas engines over and above other sources of power for all purposes. The intention of this paper is simply to direct attention to the use of gas engines for driving machine shops and to give some special information upon this subject. It is assumed that the question of cheap power applies equally as much as to the driving of our workshops as to any other users of power, and therefore the matter is of general interest. All the figures have been obtained with the greatest degree of accuracy, and calculations have in all cases been made against rather than in favor of the gas engine system.

The particular factory used as an example is of very simple design, and therefore offers no difficulties in the distribution of the power. The works are divided into two shops joined into one, and forming a covered floor space 408 x 75 ft. One portion of this, called the "old shop," is 288 x 75 ft., and the "new shop" is 120 x 75 ft. The "old shop" has two long lines of shafting, one on each side of the building, the total length being 563 ft., the diameter of which varies from 1¾ to 3½ ins. One section of this shaft is belted to a 40-HP. Stockport gas engine, and the other section is in turn belted to the first section, using a loose pulley so that the second shaft can be run or not as desired. In all 83 bearings on fixed

*Abstract of a paper read before the Manchester (Eng.) Association of Engineers on March 11, 1899.

wall brackets are used, while the 87 countershafts have 182 bearings; 2,500 ft. of belting, ranging from 2 to 5 ins., is necessary to operate the countershafts and the following machines: 4 flywheel and pulley-turning lathes; 5 crank lathes; 10 planing and shaping machines; 6 cylinder-boring lathes; 8 drilling machines; 6 milling machines; 5 capstan lathes; 35 lathes, averaging 10-in. centers; 7 machines of various sorts; 11 grinding and emery stones; 1 circular planing machine; 1 blower; 3 machines in pattern shop; making a total of 102 machines of all sorts. The "new shop" also uses a 40-HP. gas engine, and is fitted with a main shaft 3 ins. in diameter and 60 ft. long, supported by nine bearings. This in turn drives six countershafts running on 12 bearings, with a total length of 42 ft. About 400 ft. of belting from 2 to 5 ins. wide are required to drive the tools in this shop which include: 2 large planing machines; 1 flywheel turning lathe; 1 5-ft. radial drill; 1 screw machine.

The actual power required to operate the shafting alone, with countershafts and finally with all machinery running, was obtained by indicating the engines and is given in detail for both shops in the accompanying table.

"Old Shop."

	HP.
Power absorbed by the friction of the engine and driving belt on the loose pulley	8.4
Main shafting, with all countershafts running, but machine belts on loose pulleys	10.5
All machines working in the ordinary daily routine	17.75
Grindstones and emery wheels	8.2
Total	44.85

"New Shop."

Power absorbed by engine friction and driving belt on loose pulley	8.5
Countershaft for driving dynamo with the dynamo running light	3.5
Main shaft, with countershafts and all belts on loose pulleys	2.2
All machines working in the ordinary way and large flywheel lathe, three tools roughing out	7.8
5-ton electric crane; average constant HP. taken from a series of tests	1.8
Total indicated	23.8

It was somewhat difficult to ascertain the exact amount of power absorbed by the electric crane owing to its intermittent working. However, by averaging several tests it was found that the maximum power taken by the crane when loaded with six tons was:

	Effective HP.
Cross traveling at 66-ft. per minute	3.0
Longitudinal travel at 130 ft. per minute	4.6
Hoisting 15 ft. per minute	14.0

Dealing first with the power for driving the works, the "old shop" averaged 45 I. HP., and the "new shop," 24 I. HP., or a total of 69 I. HP. The gas consumption worked out at the rate of 67 cu. ft. per I. HP. per hour. The costs were taken for an ordinary working week of 53 hours, with an allowance of one hour for the time the engines are running before and after shop hours; 69 x 67 x 54 equals a total consumption of 249,642 cu. ft. of fuel gas, or about 250,000 cu. ft. Reckoning 14 lbs. of fuel 1,000 cu. ft., then the coal used equals 3,500 lbs., which at $6.07 per ton amounts to $9.47.

In this plant the gas generator is near a boiler used to furnish steam for a steam hammer, and for heating the factory. One man attends to both the boiler and the gas generator, which does not take up half his time. It has therefore been assumed that one man could easily manage the gas generating plant and both gas engines. The quantity of water required for making the gas necessary for the two engines is less than 1,000 gallons per week, while the cooling water for the cylinders is used over and over.

The cost of fuel gas per 1,000 cu. ft. figures out aa follows:

Fuel per week, 3,500 lbs. at $6.07 per ton	$9.47
Labor (half one man's time at $6.07 per week)	3.04
Water	....
Interest, depreciation and repair at 10% on $2,000.	3.88
Total	$16.40

The total quantity of gas made is about 250,000 cu. ft. per week, which gives a cost of 6½ cts. per 1,000 cu. ft.

To make a comparison with a steam engine, the complete consumption of 3,400 lbs. of fuel may be assumed equivalent to 3,726 HP. hours, or 0.939-lb. of fuel per I. HP. per hour, including all fixed losses. It may be said that the cost of the fuel used in the shop under consideration is higher than ordinary steam coal. Assuming, for the sake of argument, that it costs three times as much as the usual steam coal, the equivalent consumption is 2¾ lbs. per I. HP. for 69 I. HP., which figure compares favorably with the best steam engines of much greater power.

Tabulating the total cost for one week, we have

Fuel	$9.47
Labor (one man at $6.07 per week)	6.07
Oil and waste for engines	.97
Interest, depreciation and repairs at 10% on a capital outlay of $4,500	3.88
Total	$25.27

Which is at the rate of a little under 49 cts. per hour. Reducing the cost to a single horse-power per hour, a total of 3,726-HP. hours at a cost of $25.27, which is at the rate of 0.66 ct. per I. HP. per hour, which covers all charges.

As the two engines mentioned are worked with fuel gas, the gas consumption was obtained by filling the gasholder with gas and shutting off all connections between the producer and the gasometer. The engine was then indicated, and the number of explosions registered by the counter for each foot of fall of the gasholder. As the holder has a capacity of about 6,000 cu. ft., the result can be considered as accurate.

From frequent tests it is found that, taking an average working week of 53 hours, the quantity of anthracite coal required to produce 1,000 cu. ft. of fuel gas is 14 lbs., which includes stand-by loss, and an allowance for generating the necessary steam for making the gas.

The electric light, as previously mentioned, is generated by the same dynamo that actuates the electric crane. There are 19 arc lamps of 2,000 c.-p. each, and 31 lamps of 16 c.-p. The power used to operate the dynamo is 18 E. HP. Taking 83 cu. ft. of fuel gas per brake horse-power, and an average of 20 hours per week, the total consumption of gas is 29,880 cu. ft. at 6½ cts. per thousand cubic feet equals, say, $2.18 per week, or less than 10 cts. per hour for a total of 38,000 candles in arc lamps, and 496 candles in incandescent lamps.

The following particulars of a test made with Stockport engines at Messrs. J. & E. Hall, Dartford Iron Works, Kent, are interesting:

Indicated horse-power of two gas engines	101.47 I. HP.
Brake horse-power of two engines shown by dynamometer	85.51 "
Percentage, possible explosions: Engine No. 1	89.6%
Engine No. 2	78.0%
Anthracite coal burned per hour	56.00 lbs.
Coal burned per I. HP. per hour	.55 "
Coal burned per D. HP. per hour	.655 "
Coal for boiler per hour	18.83 "
For boiler per I. HP. per hour	.186 "
For boiler per D. HP. per hour	.222 "
Duration of test	3 hours.
Date of test	Nov. 7, 1898.

THE UTILIZATION OF TRASS MIXED WITH HYDRAULIC CEMENT IN GERMANY.

The development for engineering uses of the basalt and trass deposits from the extinct volcanoes of the Rhine valley have recently been receiving considerable attention from German engineers. One of the principal uses to which the latter material has been put is to mix it ground with hydraulic cement, and the results of some of the recent experiments of German engineers with this mixture are described in the "Engineer," of London, England, from which we abstract the following information:

The uses of trass to engineers and contractors are the subject of elaborate reports by Dr. Wilhelm Michaëlis, of Berlin, and Dr. A. Unna, city engineer of Cologne. After a number of exhaustive experiments, and many tests at the Royal Testing Station for Building Materials in Berlin, Dr. Michaëlis came to the conclusion that "of all the known additions to hydraulic cements the most effective is real trass, on account of the high proportion it contains of the hydraulic factors, and of the excellent qualities of that portion of it which acts on sand." The learned Berlin chemist forwarded an account of some of these experiments to the Institute of Civil Engineers; but as it arrived too late for the session of 1893-94, he withdrew it in order to add further results as they were attained. Subsequently, however, he was induced to place the outcome of his researches in print, in consideration, as he says, "of the marine constructions which are proceeding in many different civilized States, involving millions of capital."

It is unnecessary for the present purpose to return to Dr. Michaëlis' discussion of the duration of Portland cement in salt water. His conclusion on these points is, briefly, that a cement in which so considerable a quantity of quicklime becomes liberated, quicklime being a substance of exceptionally strong affinity, cannot be regarded as a stable compound in a chemical sense. The free lime must work and react until, in one way or another, it forms a saturated compound. This occurs first, from the surface downwards, by the absorption of carbonic acid, when the cement is exposed to the air or water containing carbonic acid; in sea water it is principally the soluble sulphuric acid compounds which react upon the lime. First the perfectly free lime changes, according to circumstances, into calcium carbonate or sulpahte, next that which is present in the form of the extremely unstable ferric oxide compound, thereupon follows the attack upon the calcium aluminate, and, lastly, on the silicate. Even the simple formation of calcium sulphate, with two equivalents of water, causes a considerable increase of volume, and is sufficient for the destruction of the cohesion produced by the absorption of water; and with this formation of gypsum is connected the development of calcic alumino-sulphate, which produces a still more formidable increase of volume, and as a result the total destruction of the cohesion, because this double compound crystallizes with at least 30, probably with 60 equivalents of water; it thus splits up grain by grain the hardest mortar with irresistible force to a completely disorganized mud, in which only the parts protected by the formation of calcium carbonates can maintain a certain degree of coherence. Dr. Michaëlis finds, in short, that, independent of physical qualities, those hydraulic mortars which are the richest in lime are the least able to withstand the action of sea water, and that nothing can be more mistaken than to add lime to such mortars when they are being prepared; wherefore "the stronger Portland cements manufactured at present proves less well adapted for marine construction than those made formerly which were poorer in lime." His verdict is that—if there are opposed to the lime, when it is in process of separating—puzzolanas, or substances which in combination with calcium hydrate form cement, the amount of effective cement in the mortar may be increased in such a way that no more caustic lime can be deposited in crystals; the entire quantity of calcium-hydrate is liberated and is employed in the formation of calcium hydrosilicate and aluminate.

The venerable Berlin chemist goes on to explain the effects of adding trass to the ingredients of hydraulic mortars. He points out that the action of sea water on these mortars is mainly chemical. In order to arrive quickly at results, everything had to be excluded which would form an artificial hindrance to the action of sea water, and therefore thoroughly porous mortars were used. Twenty years ago he discovered that a solution of calcium sulphate, with only 0.127% of sulphuric acid (SO_3) completely destroyed neat, and therefore absolutely impervious, Portland cement—"Stern" brand—and thereby he recognized that the sulphuric acid alone, not the magnesia, exerted an injurious influence on hydraulic mortar in sea water, the magnesia being merely an accompanying phenomenon, and one of the visible signs of the destruction. In two of the experiments the components were as follows:—

(1) Four parts, by weight, of Portland cement, with less than 6% alumina; two parts trass from Plaidt; ten parts quartz sand. (2) Two parts the same cement; two parts trass from Plaidt; ten parts quartz sand.

Plaidt trass contains in 100 parts by weight ten to twelve parts of water (and loss in ignition), 20 to 30 parts of hydraulic silica and alumina, and 60 to 65 parts of minerals, which act like so much sand. The trass employed in the Michaëlis test left on a fine sieve (16,000 meshes per sq. in.) 41% residue.

The tests extended over periods of 7, 28, and 90 days, and then one year. To quote Dr. Michaëlis, they show that "out of 100 parts by weight of Portland cement, containing a medium proportion of lime, about 25 parts CaO, equivalent to 33 parta $Ca H_2O_2$, become free. On admixture of 100 parta by weight of trass, which, for example, contain 16.5 parts silica and 5.14 parts alumina, capable of combination, the formation of SiO_2 CaO would require 15.4 parts CaO, and that of 2 $Al_2 O_3$, 3 CaO would require 4.2 parts CaO, or together 19.6 CaO; thus there may be formed a silicate richer in lime than the single silicate, and it is therefore very probably advisable to mix 125 parts by weight and more of trass with every 100 parts Portland cement; moreover, compounda of 2 SiO_2 to 1 to 2 CaO become exceedingly hard, and are quite certainly still more stable than the single silicate. In any case, the addition should be higher in proportion according as the cement is richer in lime; this applies equally to hydraulic mortars. After a year'a interval even here the injurious action of the sea water is making itself felt, for, in the case of this mixture of 100 cement and 50 trass, only about 10 parts by weight of the lime becoming free could be completely laid hold of, and there would still be 15 parts by weight of lime capable of reaction, so to speak, and, even if the silicate 2 SiO 3 CaO, and the aluminate 2 $Al_2 O_3$ 5 CaO were formed, 10 parts by weight of calcium oxide would still remain free for reaction with the sulphates of the sea water." The figures speak for themselves. The admixture of trass—and of puzzolanas in general—with over-limed hydraulic binding agents, Portland cements, and hydraulic limes, is capable of raising the strength of mortars made with these to two or three times what it would otherwise be, and to make these materials permanently sound in sea water. As regards the increase in strength, this is, indeed, clear at a glance; the best puzzolanas contain at least as much of the hydraulic factors as the best Portland cement; therefore it cannot but be that from the union of these materials, a hydraulic mortar of redoubled strength results, since Portland cement contains a sufficient excess of lime to admit of the puzzolana attaining its full value.

This solution of the problem, Dr. Michaëlis holds, is the most favorable that can be imagined. The old methods remain good; all we have to do is to make a sensible use of the ancient, most effective, and at the same time cheapest hydraulic mortar-formers, amongst which none takes a higher place than genuine trass. By "genuine trass" is meant the finely ground tufa—trass-stone, without any admixture of ashes or other substance. Since, however, they are associated here with the strong, energetically hardening Portland cement, the other varieties of puzzolana, which possess a smaller degree of initial energy, are also quite available. No combination, he says, should offer greater advantages in every way than that of trass—or puzzolanas similar to trass—and Portland cement, for no mortar mixture can excel this in respect of price and strength, initial energy, and power to withstand the destructive influence of the sea water. That the employment of Portland cement would suffer thereby is just as far from the fact as was formerly the groundless fear that road traffic would decrease owing to the making of the railways; as was the case there, so here also the very opposite will occur.

Dr. Unna, the city engineer of Cologne, accepts the researches of Dr. Michaëlis, and has put the results into practice. He recently contributed a paper to the Versammlung des Deutschen Betonvereins, from which we extract a few passages of useful information. He gives the comparative prices of standard cement and trass at Cologne, premising that there they may be regarded as low:—100 kilos. cement, 3.50 marks; 100 kilos. trass, 1.50 marks; 150 kilos. sand, 0.25 marks. This is the price of the raw material, to which the cost of mixing, the unavoidable waste, and the "profit on the job," must be added. Again, he gives the cost of the admixture on a standard of 24.20 marks per cu. ft. of mortar:—(a) 1 part cement, 1 trass, 4 sand, 1.16 water, 16.60 marks; and (b) 1 cement, 1 trass, 4.5 sand, 1.20 water, 15.70 marks. His experiments show a somewhat lesser strength, relative to the cement and trass, mortars during the first twenty-eight days; but after that the strength of the cement mortars increases, and the strength of the cement and trass mortars is still on the increase after the lapse of a year, when the curves belonging to the cement mortars practically converge. On this point Dr. Unna remarks:—"It follows from the latter phenomenon that a cement mortar mixed in the ratio of 1 cement and 2.5 sand, or 1 cement and 2 sand, possesses a superior value only when it is a matter of quick setting. Even then this property is purchased at a very high price, i. e., 5.60 marks per cubic meter of mortar, compared with 2.40 marks or 1.90 compared with 0.80 marks, per cubic meter of masonry work by employing a mortar mixed in the ratio of 1 cement, 3 sand; while the same density is obtained with a cement and trass mortar five marks cheaper." The observations on masonry work, Dr. Unna says, apply equally to concrete:—"With a sand in which the interstices amount to 40%, and a gravel in which the pores represent a like percentage of the bulk, a dense concrete may be obtained by adding pure cement mortar in the proportion of 1 cement, 2.5 sand, 5 gravel, at a cost of about 13.50 marks per cubic meter, while a likewise dense concrete, consisting of 1 cement, 1 trass, 4 sand, 10 gravel, costs ten marks only, and after 28 days attains a strength equal to that of a concrete consisting of 1 cement, 3 sand, and 6.5 gravel, in which all the interstices are also filled up, though the mortar is not dense, and the cost about twelve marks." The Cologne engineer adds:—

"My experiments extend only to trass as a silicate addition, because this material comes, properly speaking, exclusively into question so far as we Rhinelanders are concerned. Trass has enjoyed great favor on the Rhine as a suitable material for mortar since time immemorial, and, previous to the introduction of Portland cement, found, indeed, almost exclusive employment, particularly for hydraulic work. Even to-day the material is worthy of high esteem; its use still continues on the increase, in part at the expense of cement, owing to the enterprise of the trass mine owners. Hence it may probably not lie in the interest of manufacturers of cement goods to push this material aside as a competitor. On the contrary, it appears to me more to the point to subject this promising source of assistance, in the improvement of cement goods, to an exhaustive and thorough test, with the idea of gaining therefrom experience which might eventually enable the introduction of improvements in the production of cement goods calculated to ensure the requisite density of the finished article."

MUNICIPAL OWNERSHIP OF WATER-WORKS IN ENGLAND AND WALES.

Municipal ownership of water-works in England, as in America, is the prevailing system. Aside from the enormous population in and about London dependent on the eight London water companies nearly all the large cities and towns have municipal supplies. An interesting study of this subject has recently been made by Mr. G. L. Gomme, Statistical Officer of the London County Council, and published by the body named. The municipalities are divided into county boroughs, municipal boroughs other than county boroughs, and urban districts. Rural districts are not considered.

The report shows that of 64 county boroughs in England and Wales only 19 are dependent on private water companies for their supply. Of the 45 county boroughs having municipal supply, one is supplied by another borough, 11 built their works originally and 33 have bought works previously built by private companies. The purchases have been going on since 1846, generally one a year, with some gaps and a number of years with two or three (never more than three purchases). All but four of the purchases were made prior to 1884, there having been one in that year, two in 1888, one in 1892, and none in the last five or six years.

In other than county boroughs purchases have been made more recently. Besides the English and Welsh cases, purchases have been made in the important Scotch cities of Dundee, Edinburgh and Glasgow.

The general plan of purchase has been to pay perpetual annuities to shareholders at rates above the dividends being paid by the companies at the time of the purchase. The municipalities have extended the works from time to time with capital borrowed at a rate of interest much below the annuity rate, so the general result has been a material lowering of capital charges. In the majority of cases the rates to private consumers have been lowered since the change to public ownership.

Nearly all of the county boroughs derive sufficient revenue from private consumers to pay all the expenses of the water-works, including capital charges, thus having to include nothing in the general tax levy on account of the water supply.

The extent to which municipal co-operation is practiced in England is partly shown by the figures in this report relating to territory supplied outside the municipalities owning the works. Confining ourselves still to county boroughs, the report shows that of the 44 borough works all but 6 supply water outside their own limits. The particulars are not available in each case, but of a total area of about 1,000,000 acres supplied by 26 borough works, 775,000 acres are outside the respective borough limits. Naturally, the bulk of the population supplied is within the borough limits, but of 4,410,000 people supplied by 24 boroughs 1,450,000 are outside the limits. The water mains go far afield, too, for of 3,715 miles connected with 16 works, 1,340, or over one-third, are outside the borough limits.

The municipalities other than county boroughs appear to be very largely provided with municipal rather than private works, most of which were built by the municipalities, but at least 54 of which have been bought from companies. Nearly one-sixth of all the municipal works listed in this report have passed from private to public ownership.

Mr. Gomme believes that municipal ownership of water-works has been a decided success in England, both in the matter of cost and character of service.

BOOK REVIEWS.

SEWAGE IRRIGATION, PART II.—By Geo. W. Rafter. Water Supply and Irrigation Papers of the U. S. Geological Survey No. 22. Washington: Pub. Doc. Paper; 6 x 9 ins.; pp. 100; seven plates and four figures in the text.

This is a continuation of Paper No. 3, in the series named above. It was prepared in 1897, with No. 3, for one paper, but the rules governing these publications limit there size to 100 pages, so Part. II. has been held over until now. The first paper was a general discussion of sewage treatment, with foreign examples. This one is devoted principally to brief descriptions of all the sewage purification plants known to be in operation, under construction or projected in the United States and Canada, in 1897. It includes plants for treating manufacturing wastes and sewage from asylums, prisons and other institutions.

CITY GOVERNMENT IN THE UNITED STATES, With a Chapter on the Greater New York Charter of 1897. By Alfred R. Conkling, formerly Alderman of the City of New York, and Member of Assembly of the State of New York. Fourth edition; revised. New York: D. Appleton Co. Cloth; 5 x 7 ins.; pp. xvi., 245. $1.

The present edition of this book differs but little from the first one, except for the new chapter, in which an outline of the charter of Greater New York is given. The volume reviews the various phases of municipal government, giving a few facts regarding the practice of different cities in administering their municipal affairs. The book is right in line with the recent movement for municipal reform; indeed, the first edition was one of the earliest of the many books on the subject. Water-works, sewerage, paving, lighting, public buildings and other like topics are discussed briefly.

PROCEEDINGS OF THE AMERICAN RAILWAY ASSOCIATION, with appendix containing proceedings of the Earlier Organizations known as the General Time convention and the Southern Railway Time convention, New York City. The American Railway Association. 8¾ x 11½ ins.; half morocco; pp. 755. $5.

This handsome volume includes all the proceedings of the American Railway Association from its organization on April 14, 1886, to and including Oct. 11, 1893, and also the transactions of its predecessors the General Time convention from 1872 to 1885 and the Southern Railway Time convention from 1877 to 1885.

A very complete index is given which makes the large amount of material contained easily accessible. The printing and binding is excellent and all in all, the volume forms a very handsome and complete record of the transactions of one of the most important railway associations of the country.

COMMERCIAL DIRECTORY OF THE AMERICAN REPUBLICS. Vol. II.—Mexico, Nicaragua, Paraguay, Peru, Salvador, Santo Domingo, United States, Uruguay, Venezuela and the West Indian Colonies. Compiled by the Bureau of the American Republics, 2 Jackson Place, Washington, D. C. Cloth; 4to; pp. 1,589. $5.

The character of the contents of this bulky volume is indicated by its title. Besides the directories, a considerable portion of the book is devoted to descriptions of the physical, geographical and commercial features of the different countries, together with their government, commercial laws and customs tariffs, patent and trade-mark laws, etc. The directories, judging them by that of the United States, are by no means complete, but are less defective in the inclusion of insignificant or defunct firms than is usually the case.

MECHANICAL MOVEMENTS, DEVICES AND APPLIANCES, containing illustrations and brief descriptions of the various movements used in constructive and operative machinery, and the mechanical arts. By Gardner D. Hiscox, M. E.; New York, Norman W. Henley & Co., Cloth; 6½ x 9½ ins.; pp. 402; 1649 illustrations, $3.

This book might properly be termed an illustrated dictionary of mechanics. In it the author has endeavored to convey to the mind of the reader the principles of a large number of mechanical movements and special machines by the use of diagramatic illustrations, and very brief explanations rather than by the usual, lengthy descriptions. The volume is intended to serve as a work of reference for inventors, mechanical students and artisans, or in fact any one interested in machine design.

The work is divided into 17 sections and covers in a general way the whole field of mechanics. Naturally, it is only possible to give the most important kinematic movements and what may be termed standard machines. These are, however, well selected and clearly shown.

THE STEAM ENGINE INDICATOR.—Directions for the Selection, Care and Use of the Instrument and the Analysis and Computation of the Diagram. Compiled from the regular issues of "Power"; edited by F. R. Low. First edition. New York: The Power Publishing Co. Cloth; 6 x 9 ins.; pp. 208; 147 illustrations; 10 tables. $1.50.

This book is a reprint of a series of articles appearing from time to time in "Power." The material has been revised and extended, and in its present form includes directions for the selection and care of the indicator, a consideration of usual forms of reducing motions and an explanation of how to apply the indicator and reducing motion. The methods of determining the meaning of indicator diagrams and all of the practical points connected with the indicator are fully set forth. For any one desiring a simple, straightforward and practical exposition of the steam engine indicator, its uses and its whims, and a clear explanation of the indicator diagram in all the forms it is apt to assume, there is, as far as we know, no better book published. It is to be regretted that so well-written a treatise should not be presented in better form. The binding is excellent; but the topography and press work are very poor.

A PRACTICAL GUIDE TO THE TESTING OF INSULATED WIRES AND CABLES.—By Herbert Laus Webb, M. Am. Inst. E. E. New York: D. Van Nostrand Co., Cloth; 5 x 7¼ ins.; pp. 118; illustrated. $1.00.

This little book is a reprint of a series of articles which appeared originally in "The Electrical Engineer." Their reception at that time warranted the publication of the information in book form.

The idea of the author is to present as clearly and briefly as possible the principles of wire and cable testing, together with sufficient practical information regarding the various instruments employed in the testing room to make the book of value to those actually engaged in the work of testing or those wishing to become acquainted with the methods in vogue.

Galvanometers, keys, batteries, the Wheatstone bridge, condensers and the other standard accessories are described, while under the heading of testing the methods of determining insulation resistance, conduction resistance and capacity are given with sufficient detail to fairly well accomplish the author's intention.

CHIMNEY DESIGN AND THEORY.—By William Wallace Christie, M. Am. Soc. M. E., New York, D. Van Nostrand Co. Cloth, 8vo., pp. 164, illustrated. $3.

This is the latest and most complete book on this subject, in regard to American practice, and is very fully illustrated with examples of modern practice. The theoretical portion deals with area, height, draft, fuel consumption, etc., and the relations of the several portions are given in tabular form. Numerous other tables and formulas are also given. The character and construction of the foundations are also considered. Separate chapters are devoted to steel and brick chimneys, with numerous examples of design and construction of individual chimneys, and there are also lists of large steel and brick chimneys. The chapter on "Chimney Performance" gives particulars of fuel consumption, etc., of boiler plants having chimneys of given dimensions. Cast-iron and concrete chimneys, the straightening and renewing of chimneys, the design of flues, and the means of protection from lightning are all dealt with, as are also house and office-building chimneys. The index is lengthy but not well compiled.

SEWER DESIGN.—By H. N. Ogden, Assoc. M. Am. Soc. C. E., Assistant Professor of Civil Engineering, Cornell University. New York: John Wiley & Sons. London: Chapman & Hall. Cloth; 5 × 7 ins.; pp. 234; 5 plates; 59 illustrations in the text and 25 tables. $2.

This excellent little book is confined almost wholly to a discussion of the data relating to volume of sewage, how to gather it and how to use it with intelligence and discrimination. An analysis of the contents shows that the book is divided, roughly, into a consideration of the amount of sewage and storm water to be provided for, including rainfall, population, water consumption and infiltration; formulas and diagrams; maps and plans; and some matter on sewer cross-sections, flushing and the use of flush tanks. Such details as manholes, catch-basins, house connections and ventilation are not considered, partly because the book is for the most part a series of lectures to Cornell students, which must not overlap other lectures in the course. These limitations, when recognized, are not against the book. They permit a clearer and fuller presentation of the subject than is possible, or at least probable, where more ground is covered. Besides this, the matter is likely to be fresher when limited in scope, since with modern advances in engineering some portions of more comprehensive, or inclusive, works are apt to become out of date while the others are being prepared.

THE INTERNATIONAL YEAR BOOK.—A compendium of the World's Progress in Every Department of Human Knowledge for the Year 1898. Editor, Frank Moore Colby, M. A., Professor of Economics in New York University, Consulting Editor, Harry Thurston Peck, Ph. D., Professor in Columbia University, New York; Dodd, Mead & Co., Cloth; 7 x 10 ins.; pp. 932; illustrated with folding maps and engravings and cuts in the text. $3.

Every one who has occasion to use encyclopedias knows to his sorrow how soon they become out of date. The purpose of this Year Book is to serve in some respects as a supplement to the encyclopedias, at the same time giving as complete a review as the limits of a single volume will allow of the year's doings in politics, science, literature and art, not forgetting biographical matter. The volume before us gives evidence of having been prepared with care. A notable feature of the book is the unusual amount of space, which has been given to engineering.

The various articles under this head have been prepared by members of the editorial staff of Engineering News, divided as follows: Bridges, Canals, Railways, Tall Buildings and other civil engineering subjects, Mr. Charles S. Hill; Municipal Engineering, including Water and Sewage Purification and Garbage Disposal, Mr. M. N. Baker; Electrical and Mechanical Engineering and Industrial Arts, including Motor Vehicles and Liquid Air, Mr. John Joseph Swann, Assoc. M. Inst, E. E. The number of illustrations in the volume is not large, but for the most part they are remarkably well chosen and presented. The typography, presswork and binding are good, especially in view of the low price of the books.

ENGINE-ROOM PRACTICE.—A Handbook for Young Marine Engineers: Treating of the Management of the Main and Auxiliary Engines on Board Ship.—By John G. Liversidge, Chief Engineer, R.N. London, Charles Griffin & Co.; Philadelphia, J. B. Lippincott Co. Cloth, 8vo., pp. 292; illustrations, 67. $2.50.

This is a thoroughly modern book, dealing solely of modern practice with the now almost universal type of vertical, inverted marine engine in naval and mercantile steamers. The particulars with regard to the use and maintenance of the auxiliary machinery occupy a goodly portion of the book, since this machinery involves a much greater number of parts and methods of operation than the main propelling engines. Thus it is shown that the I. HP. of the three main engines of the U. S. triple-screw cruiser "Columbia" is 18,000 HP., while the auxiliary machinery includes nearly 50 pumps, fans, dynamo engines, etc., aggregating 518 HP. The conditions of service in the naval and mercantile service are described, with the duties and discipline. Starting with preparations for raising steam, particulars are given of the cause of procedure in commencing, running and ending a voyage, as far as the engine-room and boiler-room service is concerned. The duties and difficulties involved are so numerous that the reader will almost consider it hopeless for any ordinary mortal to attempt to cope with them until he remembers that much of the work is routine and incidental, being less formidable in reality than it looks in print. Two important chapters are devoted to the repairs and adjustments of machinery and boilers, the former including the question of steam pipes. Pumps, hydraulic and electric plant, feed-water heaters, evaporators, refrigerator plant, etc., are dealt with, as are also the various doors, valves and pipes which form part of the hull fittings but are under the engineer's charge. Harbor duties and dry-docking are briefly described, and a chapter is devoted to the machinery and boilers (Belleville) of torpedo boat destroyers. The appendix contains the regulations and examples of examinations for engineers. The book is small and compact, and has large, clear type.

THE MUNICIPAL YEAR BOOK OF THE UNITED KINGDOM FOR 1899. Edited by Robert Donald, Editor of "The Municipal Journal and London." London: Edw. Lloyd, 12 Salisbury Square, E. C. Cloth; 5 × 7 ins.; pp. 480. 72 cts. (including postage to America) in England; $1 in America.

Aside from being a directory of the officials of about 425 municipalities in England, Wales, Scotland and Ireland, this handy volume gives quite a variety of useful information under each town regarding its principal municipal undertakings. This information includes population, area, rateable value, year chartered, date of installing various public works, and outline descriptions of the baths, cemeteries, electric and gas lighting, markets, refuse and sewage disposal, technical education, slaughter houses, street railways and water-works under municipal ownership, besides miscellaneous statistics. The lighting, water supply and street railway information, where under municipal control, is given, for the most part, in separate chapters, with references to the corresponding page numbers under the several towns. The same is true regarding artisans' dwellings and municipal lodging houses. There are brief sections on municipal government in London, and on the English and the Scotch forms of municipal government.

The chapter on water supply gives, for the more important works, some historical facts, especially regarding changes from private to public ownership; some facts regarding the source and mode of supply, total and per capita consumption; cost, debt, interest charges, expenses, revenue and rates for domestic consumption. The same general plan is followed for gas and electric lighting plants, except that nothing is said regarding the character of the works. Rather more information is given regarding street railways (or tramways) than under water and lighting, the accounts going into more detail regarding changes from private to municipal ownership; giving also the length of line, passengers carried, proposed changes in motive power and summarized financial statements.

Altogether the volume is a remarkably handy one, brimful of information in condensed form. We are glad to bring it to the attention of municipal officers and those interested in municipal affairs in America. The low price places it in the reach of all.

A MANUAL OF LOCOMOTIVE ENGINEERING. With an Historical Introduction. A Practical Text Book for the Use of Engine Builders, Designers and Draftsmen, Railway Engineers, and Students.—By William Frank Pettigrew, M. Inst. C. E., M. Inst., M. E. With a section on American and Continental Engines, by Albert F. Ravenshear.—London, Charles Griffin & Co.; Philadelphia, J. B. Lippincott Co. Cloth, 8vo., pp. 430, plates, 9; illustrations, 280. $6.50.

This comprehensive and somewhat ambitious English work is very fairly representative of modern practice, and combines two distinctive features which are not usually found in books of this class: (1) a description of design and detail parts considered generally, and (2) a description of the details of practice on individual railways. The book commences with the history of the locomotive from 1763 to 1863, but the "Rocket" is shown as subsequently altered, though no explanation is given of this. The simple and compound locomotives used on a number of individual lines are then briefly described, and a good many English readers will probably be surprised at the extent to which the once-despised truck or "bogie" is now used. The practical introduction of the compound system is rightly attributed to Mr. Mallet, of France, and it is noticeable that this system has met with but little favor in England. In fact, only one road is now using it to any extent. The Webb, Von Borries, Worsdell, Lindner and Vauclain systems are briefly described, but it should have been stated that since Mr. Worsdell's retirement his system has been practically abandoned. There is no discussion of the relation of compounding to fuel economy, but we find it stated that on the London & Northwestern Ry. Mr. Webb's three-cylinder compounds have effected a saving of 22% in fuel, as compared with the simple engines. And yet English writers not unfrequently claim that American records of 15 to 20% economy are either incorrect or else that the fuel consumption of the simple engines is excessive.

The author then proceeds to discuss certain primary considerations in locomotive design, but in discussing train resistence he makes the mistake of naming Mr. Sinclair as being connected with Engineering News. The next few chapters are devoted to details of rods, axles and boxes, guides, valve gear, etc. The Allen valve is disposed of with the remark that it is not now used to any extent, which is certainly incorrect as far as this country is concerned. In the chapter on boilers no reference is made to arched crown sheets or radial stays for fireboxes. Steel fireboxes are shown to be in use on the Great Eastern Ry. The boiler mountings described and the tenders are all representative of English practice. The chapter on American locomotives is fairly accurate, but we find some rather curious statements (of minor importance) due to insufficient knowledge. This is particularly true of the remarks on cast-iron wheels. Different types of continental locomotives are described, but the author fails to comment upon the objectionable complication of parts in the "Corliss" valves and valve gear of certain French locomotives. The book concludes with complete specifications for an English eight-wheel locomotive, and with tables of dimensions of a number of English and foreign locomotives.

The book is mainly descriptive rather than analytical or critical, and this is its weak point, its usefulness being thus materially reduced. It is fairly well printed, but the illustrations are poor, most of the cuts are made from very crude drawings, or are over-reduced from detail drawings, and nearly all of them are badly printed. The index is not well compiled, but is helped out by a table of contents and a list of illustrations and tables.

STEAM-BOILER PRACTICE in Relation to Fuels and their Combustion and the Economic Results obtained with various Methods and Devices.—By Walter B. Snow, S. B., M. Am. Soc. M. E. New York: John Wiley & Sons. London: Chapman & Hall, Limited. Cloth; 8vo.; pp. 297. $3.

The object of this work is thus stated in the preface:

There appears to be a place for a work simple in its treatment and reasonably comprehensive in its character, which shall deal primarily with effects rather than with causes, which shall undertake to indicate the possible gain or loss to result from a given arrangement, and shall point the way toward securing the highest efficiency in steam-boiler practice.

The introductory chapter contains a brief statement of the general conditions upon which steam-boiler economy depends, such as the quality of water used, the heating power of the fuel, the character of furnace, the extent and arrangement of the heating surfaces, the primary cost of the entire plant and the fixed charges thereon, and the cost of operation. Chapter II. treats of water and steam, and includes water and steam tables, and a brief treatment of the heat unit, latent heat, etc. Chapter III. discusses combustion in the usual theoretical manner, and treats also of the air required for combustion, of the analyses of the gases, of the calculation of the air supply from the analysis, and of the determination of the heating value of fuels. Chapter IV. treats of the classification and quality of fuels. It contains a table, covering ten pages, of analyses and heating value of American coals compiled from various sources. This table could be improved by excluding from it many of the results which appear to be erroneous. The author does not seem to be aware that on account of the imperfection of calorimetric determinations many published results give heating values which are at least 10% less than the true values.

Chapter V. discusses efficiency of fuels. The author gives a new meaning to the term efficiency of fuel, which is not to be commended. Thus, if carbon is taken as having a heating value of 14,650 B. T. U., and a certain coal has a heating value of 10,250 B. T. U., its "theoretical efficiency" is stated by the author to be 70%, but if the boiler efficiency is only 50%, then the "efficiency of fuel" is said to be 35%. There is enough confusion already in regard to efficiencies of various kinds without this new one, which we believe is original with the author. He also gives a new definition of the "unit of evaporation," thus: "The evaporation per pound of coal reduced to this basis (that is, the basis of water at 212° and steam at the same temperature) is known as the unit of evaporation." The definition of this unit given by the Committee on Boiler Tests of the American Society of Mechanical Engineers has nothing to do with coal. It is simply a sort of large heat unit, and is equal to 965.7 British thermal units. This chapter contains much useful information compiled from different sources, but it seems to lack logical arrangement. The portion devoted to the subject of prevention of smoke is very brief and incomplete, and some statements in it will bear revision, such as the following:

Beyond certain factors, such as sufficiency of draft, a good fireman is, after all, the most important factor in increasing efficiency and preventing smoke.

If the author had much experience with smoky western coals he would learn that no amount of draft and no degree of skill on the part of the fireman will avail to prevent smoke unless some appliance especially designed to prevent smoke is used, such as an automatic stoker in combination with a fire brick combustion chamber, or a down-draft furnace in combination with a skillful fireman.

Chapter VI, on efficiency of steam-boilers, covers 40 pages. It has much interesting matter, but some of it is open to criticism. A table is presented on p. 143 giving the efficiency of different types of boilers, which indicates that water-tube boilers have about 20 p. higher efficiency than tubular boilers with Illinois coal. The author gives no information as to the causes which led to this large difference of economy, nor any statement to show that the figures might have been reversed under different circumstances. Mechanical stokers are treated in this chapter, but to the extent of only three pages, an amount which seems quite inadequate in view of the recent great increase in use of these appliances. Chapter VII, on rate of combustion, chapter VIII, on draft, chapter IX, on chimney draft, and chapter X, on mechanical draft, are the most valuable in the book. These chapters seem to be written more from the experience and study of the author, and less from compilation, than the earlier chapters, and they contain much useful and valuable information. On the whole, in spite of numerous defects, some of which we have pointed out, the book is one which may be commended to students of the subject.

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