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EDITORIAL:

A 180-MILE ELECTRIC RAILWAY is to be built in the State of Kashmir, India. Electricity has been adopted as the motive power because of the severe grades encountered on the line, the scarcity of fuel and the availability of abundant water power. The latter is furnished by the Chenab River, which, at Ramband, half way between the terminal points, Tumu and Scrinagar, has a fall of 20 to 25 ft. to the mile, so that it is estimated that a canal 7½ miles long, giving a head of 150 ft., will furnish 100,000 HP. The total cost of road and equipment will be between $3,500,000 and $5,000,000. It has not been determined whether the State of Kashmir will do the work, or grant a concession to outside capitalists. Kashmir is the northerly and most mountainous part of the Indian Empire, with an area of 80,000 sq. miles. Its chief town is Scrinagar, which is most easily reached from the western side of the territory, Bombay being the port of entry. Punjab, which adjoins Kashmir, has great resources in the way of water power. The Government of India has lately sanctioned the construction of 550 miles of 30-in. gage "tramways" in the various provinces, and it is quite likely that many of these will be operated electrically, like the one under consideration. A syndicate has been formed at Simla with the object of utilizing the power of the Sutlej River from the north of Simla to Rohur for generating electric energy. Below Belaspur this river bends to the south and back again, forming a loop of about 40 miles, the neck at the opening of the loop being about six miles across. The hills bordering the river in the first part of the loop's course are in some places not more than 10,000 or 12,000 ft. wide, and through these it is proposed to construct a tunnel, which would give a drop of 120 ft. into some of the numerous "nulluhs" that flow into the southern part of the loop. 5,000 to 10,000 HP. will be developed here to operate the Kangra Railway, the Kalka-Amballa Railway and the projected railway from Kalka to Simla, which have already been mentioned in Engineering News. Coal and wood are yearly increasing in price in Northern India, and further developments of hydraulic power with electric transmission will probably be made.

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WATER POWER FROM THE CHICAGO DRAINAGE Canal is being discussed by a special council committee for utilization in operating the various water and sewage pumping plants of Chicago, as well as electric lighting plants and bridges. It is argued that this power should be acquired by the city from the Sanitary Board, without cost to the city, and in return for extra expenses incurred by the city in constructing larger intercepting sewers needed by the Sanitary Board to obtain the necessary amount of water for dilution. It is estimated that 20,000 HP. would be available in the first few years, and with the full flow turned on this would be increased to about 32,000 HP.; this would mean about 16,000 HP. net to the city; and that it would require about $3,000,000 to erect and equip the generating plant. There are a number of legal questions involved, and these are now under discussion.

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ELECTRIC TRAMWAYS IN ST. PETERSBURG are to replace the existing methods of street service on the principal streets, by order of the municipality of that city. A committee appointed has decided that the overhead system should be adopted, with ornamental posts suitable for supporting arc lamps. The rolling stock ordered includes 60 cars capable of carrying 52 passengers each, each fitted with two motors giving a maximum speed of "5.6 miles per hour." Each car will be lighted by ten incandescent lamps, says "Le Genie Civile."

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A TRANSFER STEAMER FOR LAKE BAIKAL, to be used as a link in the Trans-Siberian railway system, is nearly completed and will be ready for service next summer. This 4,200-ton steamer was built by Sir W. G. Armstrong, Whitworth & Co., and then taken to pieces and shipped to St. Petersburg. From there it was taken about 5,000 miles overland to Listvenichraia, on the shore of the lake, and was there put together and launched. The steamer is 290 ft. long and 57 ft. beam, and is fitted with three sets of triple expansion engines working at 160 lbs. pressure. Two of these engines drive twin propellers at the stern, and the third engine operates a propeller at the bow which disturbs the water under the ice and assists the heavy steel bow in breaking it up.

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STEAMER TRANSPORT, from England to the Caspian Sea, is described in "The Engineer." The steamer "Meridian" was built by R. W. Hawthorn, Leslie & Co., and was sent to St. Petersburg, and she is one of four built for the same Caspian service. The "Meridian" is 225 ft. long, 32 ft. beam, 14 ft. 4 ins. deep; deadweight capacity 785 tons on 9 ft. draft. At St. Petersburg these steamers were secured to six pontoons in such manner as to considerably reduce their draft, and then taken through the Marinski canal system and down the Volga to their destination. Previous vessels built by the same firm were cut in two by means of two adjoining watertight bulkheads amidships; but as the locks on the canal have since been lengthened, the second pair of vessels was constructed in the ordinary way.

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THE CUNARD STEAMSHIP "IVERNIA," lately launched at the yard of C. S. Swan & Hunter, is intended to run between Liverpool and Boston, and is mainly designed for the carriage of cargo, third-class passengers and cattle; although 150 first and 200 second-class passengers are provided for. She will carry 1,000 third-class, with 500 accommodated in 2, 4 and 6-berthed staterooms. Stalls are fitted for 800 head of cattle and 80 horses. The "Ivernia" is 600 ft. long over all; 580 ft. between perpendiculars; 64½ ft. extreme beam; molded depth to upper deck, 41½ ft.; molded depth to shelter deck, 49½ ft.; gross tonnage, about 13,900; trial speed, 16¼ knots. There are four complete decks and a steel orlop-deck. The engines are quadruple expansion, with cylinders 28½, 84, 58½ and 41-in. diameter and 54-in. stroke. There are 9 single-ended main boilers, 15½ ft. diameter by 11½ ft. long, constructed for a working pressure of 210 lbs., and arranged in three rows, two back-to-back; there is also one donkey boiler, 14½ ft. diameter by 19 ft. long, placed on the main deck. The one double funnel is 15 ft. diameter and 140 ft. high from the keel. The engines were designed by Andrew Laing, General Manager of the Wallsend Works.

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THE MOST SERIOUS RAILWAY ACCIDENT of the week was a head-on collision on the Great Northern system at Glasgow, Mont., Sept. 27, between an unloaded engine and a freight train. Five men were killed.

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A PECULIAR ACCIDENT OCCURRED at Elkhart, Ind., Sept. 23, on the Chicago & Alton R. R. The south-bound limited express was derailed by a defective frog, and the end of a rail entered the floor of the smoking car and passed up through the roof. It was followed by the succeeding rails, eight 30-ft. rails, in all, passing in this way through the car. One of the passengers was struck in the forehead by the entering rail and killed. We are indebted to the General Superintendent of the company for further particulars concerning the accident, as follows:

> Sir: Your communication of Sept. 28 to the Chief Engineer of this company has been referred to me. In reply I beg to advise that an accident occurred at the point mentioned in the clipping. The number of passengers injured is correctly stated. The rail was not broken and the cause of the wreck has not been determined. Eight rails went through the bottom of the coach in the forward end and out through the top at the rear end. Apparently, the locomotive cut the bolts holding the angle-plates to the rails. The plates were forty inches long. The end passing through the car had the two angle-plates attached, intact. I am unable at this time to give you any further information as to the cause. The frog was a spring-rail plate frog. After the accident it was found to have a broken spring bolt and a broken guide bolt, with the wing-rail shoved ahead 18 ins., otherwise it was intact. The train was apparently derailed at the frog, which is on the east side, although the wheels left the rails on the west side of the track.
>
> Yours truly,
> Willis E. Gray,
> General Superintendent, Chicago & Alton R. R
> Bloomington, Ill., Oct. 3, 1899.

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THE SIMPLON TUNNEL, says the "Revue Generale des Chemins de Fer," for September, 1899, had made the following progress on June 30, 1899, in driving the two parallel galleries: North side, 1,293 m.; south side, 695 m.; total, 1,988 m., or 6,250 ft. The average daily advance for both sides is a little more than 9 m., or about 30 ft.; but the contractors will have to average about 21 to 23 ft. per day at each face, or 42 to 46 ft. per day in all, to meet their contract engagement. On the north side they are meeting strata of gypsum and anhydrite, which requires careful timbering; there is about 10 gallons of water per second to care for. On the south side the rock is exclusively gneiss, very hard, but dry. About 2,600 men are at work, with 12 drills. The calculated length between the two heads of the tunnel is 19,728 m., or 12.23 miles.

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A TUNNEL UNDER THE HOOGHLY RIVER, at Calcutta, is proposed, according to "Indian Engineering." One plan submitted calls for two iron-lined tunnels, each 17 ft. diameter and laid 16 ft. apart in the clear. The river, at the proposed site, is 36 ft. deep at low water, and the tunnel crown would be 12 ft. below the river-bed. The tunnel would be in three sections: 1,290 ft. under the river proper, and nearly level; and two 2% inclined approaches of 2,835 ft. and 2,750 ft. respectively, making the total length 6,875 ft. Connected with these two tunnel approaches would be an open cut, roofed over, 1,500 ft. long on each side. No estimate of cost was given.

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WIRELESS TELEGRAPHY was successfully used by Signor Marconi in transmitting the news of the International yacht race, Oct. 3, to the New York "Herald." One set of instruments was installed on the steamship "Ponce," an excursion steamer, and another set was placed on the Navesink Highlands, from whence the messages were sent by wire to the New York office. The army and navy were officially represented at each of the wireless telegraphy stations, and it is stated that further tests will be made in the interests of the government.

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THE CLAIMS OF THE ERIE CANAL CONTRACTORS are being settled by the State Canal Board. On 34 contracts uncompleted the contractors are willing to have their contracts cancelled, provided the state returns to them the deposit of 5% on the value of the contract and pays them the 10% on completed work retained by the state to cover possible defects. Before the $9,000,000 appropriation was exhausted 24 contracts had been completed and payment made on them, out of the total of 74 contracts. Pulford & Compton have sued the state for the full amount of work and estimated profits on extra work; and nine contractors, holding 15 contracts, have not made any application, and probably await decision on the Pulford & Compton suit, as a test case. The Canal Board is acting cautiously, and so far has cancelled only two contracts held by Clinton Beckwith, and have ordered that his retained money be paid to the amount of $1,301.85 and $4,567.52 on the two contracts. In these cases there was no question of improper classification or bad work; and though the contractor was behind time, he had good excuses in heavy floods and difficulty in obtaining stone.

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A NEW GAS COMPRESSOR PLANT for the Chicago Pipe-Line Co. has recently been completed at Fairmount, Ind., which is 168 miles from Chicago, and is said to be in the best gas-producing territory in Indiana. The natural pressure of the gas here is in some cases as high as 200 lbs. per sq. in. The old pumping station from which Chicago has been supplied is at Greentown, six miles east of Kokomo. This was at one time the best district in Indiana, but it is now on the outside of the field proper. However, there are some very good stations yet on the Greentown station lines. The Chicago company has taken good care of its wells and has not drawn as much gas for its 10,000 consumers as have many small Indiana towns, where the gas has been indiscriminately wasted. The company has leased 40,000 acres at prices of from $1 to $5 per acre and $100 for every producing well drilled. The delivery from some of the best wells is 3,000,000 to 4,000,000 cu. ft. per day. Some opposition has been met from local manufacturers, who have organized to fight the pipe-line companies, basing their action upon the laws of Indiana, which forbid piping gas out of the state, applying an artificial pressure, or carrying a pipe pressure of over 300 lbs. per sq. in.

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THE MINING INDUSTRIES OF AFRICA are noted by the U. S. Treasury Bureau of Statistics in the form of a monograph on "Commercial Africa for 1899." From it are obtained the following brief notes: The Kimberly diamond mines, though only discovered in 1867, now supply 98% of the diamonds of commerce, and it is estimated that $350,000,000 in value of rough diamonds have been taken out since 1869, and this value is doubled by cutting. These mines are now worked under an agreement limiting the annual output so as to about meet the annual demand. The Great Witwatersrand, or Johannesburg gold mines, in South Africa, occupying a strip of territory a few hundred miles long and only a few miles wide, were discovered in 1883, and $50,000 in gold was taken out in 1884. But in 1897 and 1898 about $55,000,000 represented the gold output for each year. Since 1884 the Rand has produced over $300,000,000 in gold; and careful surveys by drills, etc., estimate the ore "in sight" at $3,500,000,000, while new mines continually being located will add to this amount.

THE WHITE PASS & YUKON RY.

When the great rush to the Klondike region in Alaska began, in 1897, the means of transportation from the coast to the gold fields were slow, of limited capacity, and dangerous. Various projects were put forward for railways into this new and almost unknown region, but the only ones which were actually carried into effect were the White Pass & Yukon Ry. and the Chilkoot Pass cableway. These were rival schemes, but the railway company has acquired control of the cableway, which is now being dismantled.

The line of the White Pass and Yukon Ry., as shown by the map, Fig. 1, is to extend from Skagway (Alaska) on the coast, to Fort Selkirk (Canada), on the Yukon River, a distance of about 380 miles. Beyond Fort Selkirk there is open navigation to Dawson, which is the center of the Klondike region. The road is now completed from Skagway across the summit of the Coast Range at White Pass (which is on the international boundary) and thence down to Lake Bennett, a total distance of 41 miles.

The plan and profile of this first portion of the road are given in Fig. 2. The road commences at a wharf in 30 ft. of water, and runs through the principal street of the town. It reaches Boulder, 5 miles, by a grade of about 1%, but beyond this there is an almost continuous grade of 3.7 to 3.9% to the summit, at White Pass, 20 miles from Skagway, the summit elevation being 2,885 ft. A level stretch and some grades of 1% and 2% bring the line to Log Cabin, 32 miles, beyond which the line descends by long 3% grades to Bennett. The water surface of Lake Bennett is 2,165½ ft. above sea level.

From Boulder to White Pass very heavy work was encountered, involving a large amount of rock excavation. Figs. 3, 4 and 5 are reproduced from photographs taken on this part of the line. Fig. 3 shows the commencement of work at Fisk's cut, on Tunnel Mountain, the elevation of subgrade being over 1,000 ft. from the bottom of the canyon. In many places the slope was so steep and unbroken that the men had to be secured by ropes, to keep them from slipping down or being blown off by the furious winds, while drilling the holes for blasting. In Fig. 4, the white cross shows the location of a tunnel, the heading for which was started by men let down by ropes from the top of the cliff, the face of the precipice affording no footing. This tunnel is 500 ft. long, and is approached by a trestle.

Fig. 5 shows the completed road at Rocky Point. Here the side of the mountain rose so straight and unbroken, that in order to form a bench for the roadbed it was necessary to blast away the entire face of the spur. The mass of rock dislodged was about 120 ft. high, 50 to 70 ft. long, and 15 to 20 ft. wide. This was hurled by one blast to the bottom of the canyon, 700 ft. below. It may easily be imagined that there was little difficulty in disposing of the debris, but in one case the rock blasted away blocked the wagon road below, and the cost of clearing the road was almost as great as that of preparing the grade for the railway. These views give some idea of the character of the work, and behind the train, in Fig. 5, may be seen one of the trestles required to carry the line in front of the smooth and almost vertical face of the rock. Beyond the pass, the work is much less severe, the excavations being largely in earth and gravel, with only light rock cuts. The maximum grade is 3.9%, and the minimum curves are of 16°. There is one switchback (Fig. 2) which will ultimately be replaced by a curve.

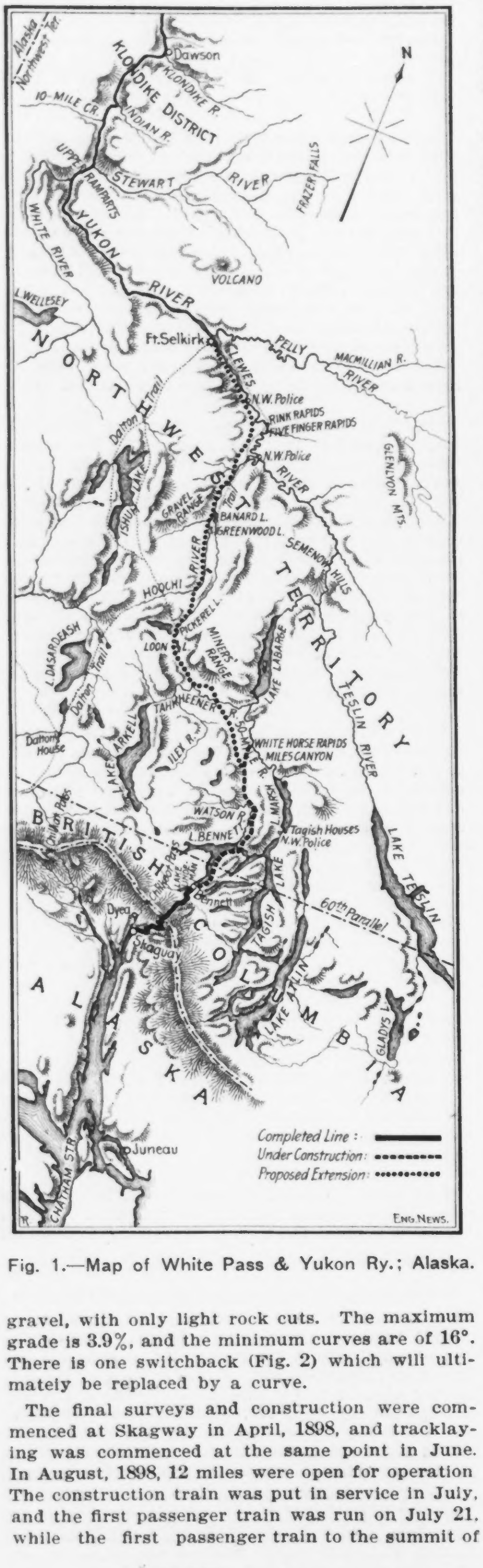

Fig. 1.—Map of White Pass & Yukon Ry.; Alaska.

The final surveys and construction were commenced at Skagway in April, 1898, and tracklaying was commenced at the same point in June. In August, 1898, 12 miles were open for operation The construction train was put in service in July, and the first passenger train was run on July 21, while the first passenger train to the summit of White Pass was run on Feb. 20, 1899. The line was completed to Lake Bennett on July 6, 1899. From 1,200 to 1,500 men were employed in construction, and the first 20 miles of the road cost $1,200,000, or $60,000 per mile.

The railway has a track of 3-ft. gage, laid with 50-lb. rails, and is ballasted with gravel. For that part of the line from Skagway to the pass, the gravel was mainly obtained from the Skagway river. Beyond the pass, however, the country affords an abundant supply of gravel.

The equipment includes about ten locomotives, mostly of the mogul and consolidation types; 7 passenger cars, 100 freight cars, and a number of flat cars. Additional equipment has recently been ordered, including a Leslie rotary snow plow, built by the Cooke Locomotive Works, Paterson, N. J. The four-cylinder, Vauclain compound consolidation engines have their frames outside the driving wheels, necessitating the use of overhung crank arms on the axles. They were built by the Baldwin Locomotive Works, of Philadelphia, Pa., and their leading dimensions are as follows:

Driving wheels	3 ft. 2 ins.
Truck wheels	2 " 0 "
Wheelbase, driving	11 " 6 "
" total	18 " 6 "
" engine and tender	43 " 8½ "
Weight on drivers	80,000 lbs.
" total engine	89,500 "
" engine and tender	150,000 "
Cylinders	11½ × 20 ins., and 19 × 20 ins.
Boiler, diameter	4 ft. 6 ins.
Firebox	50⅛ × 45¼ ins.
Tubes 120; diameter	2¼ "
Tubes, length	15 ft. 2¾ "
Heating surface, tubes	1,069.81 sq. ft.
" firebox	65.38 "
" total	1,135.19 "
Grate surface	15.70 "
Tender tank capacity	3,000 gallons.

Construction has been commenced for the division extending from the foot of Lake Bennett to a point on Fifty-Mile River, below the dangerous White Horse Rapids. This distance is 41 miles, and these two divisions, with the navigation on Lake Bennett, will give a safe and practicable route into the interior. Eventually the two divisions will be connected by a third, following the banks of the lake. This will be 26 miles long and will involve some heavy rock work.

The entire road is known as the White Pass & Yukon Ry., but will be built under three separate charters, all held by the same parties. The United States charter for the division from Skagway to White Pass (in Alaska), 19.6 miles, is held by the Pacific & Arctic Railway & Navigation Co. The British Columbia charter, for the division from White Pass to the 60th parallel, 21.4 miles, is held by the British Columbia Yukon Ry. Co. The Canadian government charter, for the division from this boundary to Fort Selkirk, 340 miles, is held by the Yukon Mining, Trading & Transportation Co. Mr. S. H. Graves, of Chicago, is President of all these companies. Mr. E. C. Hawkins is Chief Engineer and General Manager. Mr. John Hislop is Assistant Chief Engineer, and Mr. F. H. Whiting is Division Superintendent. The construction work is in the hands of the Pacific Contract Co., of Seattle, Wash., of which Mr. Graves is also President.

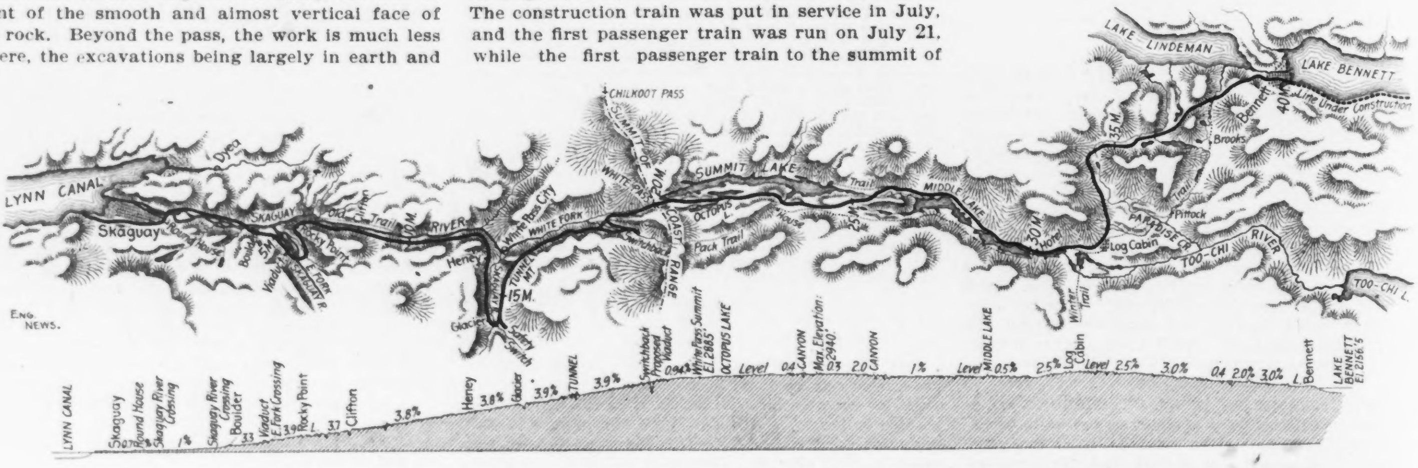

FIG. 2.—MAP AND PROFILE OF COMPLETED SECTION OF THE WHITE PASS & YUKON RY.; SKAGWAY TO LAKE BENNETT.

DISTRIBUTING GAS UNDER HIGHER PRESSURE.*

By. F. H. Shelton.†

I have for some time been impressed with the low pressure at which illuminating gas is distributed, amazingly low when one thinks of it and compares it with the practice in the distribution of other fluids. I have been wondering at the reason of it; wondering whether there is good reason for continuing it, and wondering whether it would not be advantageous to distribute gas at a higher pressure than is the common practice.

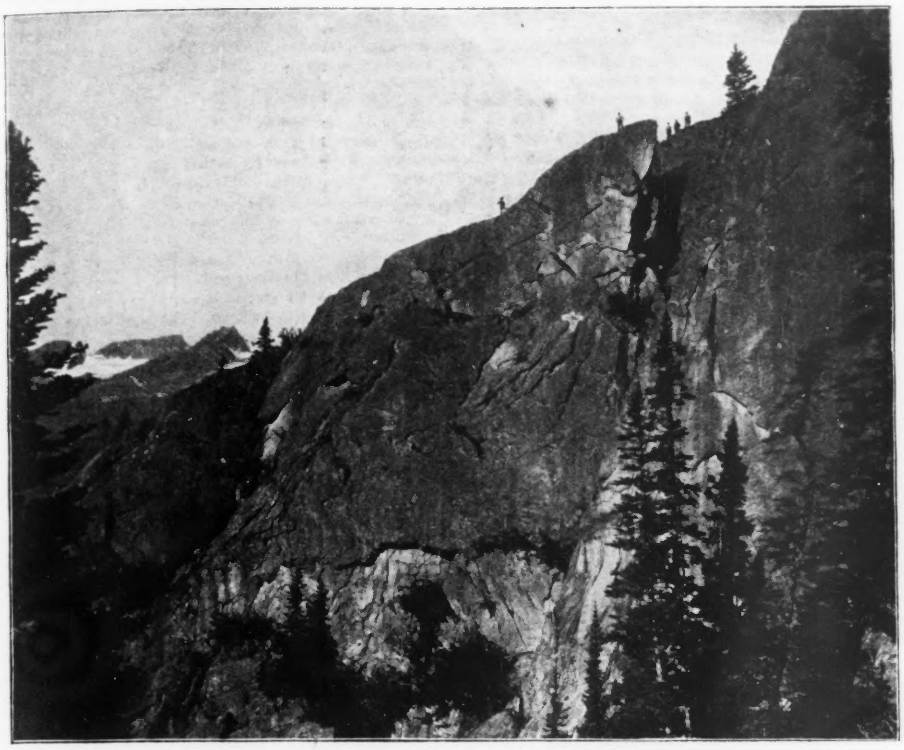

FIG. 4.—SITE OF TUNNEL.

Water is distributed frequently with pressures of from 100 to 300 lbs.; natural gas is distributed at all ranges of high pressures, even the "low pressure" systems often ranging at a number of pounds pressure. Steam, I believe, is distributed in the most crowded streets of some of the principal cities at 200 or 300 lbs. pressure. Low pressure steam-heating systems in house work operate at 1, 2 and 3 lbs. pressure, which we think is almost no pressure at all. Yet illuminating gas is commonly distributed at but 2 or 3 ins. of water pressure, which is equivalent to but ⅛ or 1-10 lbs. steam pressure. A mere zephyr, a pressure so slight as to scarcely more than induce motion, a pressure so slight that boys in dormitories by blowing down a burner can overcome the pressure for some considerable distance in the house pipes and extinguish lights in adjoining rooms. Why should not gas be distributed at higher pressures, not necessarily at 100 or 200 lbs. (although just as well that if desired), but at any rate at 5, 10 or 20 lbs. pressure, instead of ½ or ⅓-in., and thus make small pipes handle large quantities of gas? According to accepted authorities, other things being equal, four times a given pressure will double the delivery of gas. Taking an average of 2 ins. as a starting point in common practice, about 5 lbs. pressure would mean, therefore, a delivery of about eight times as much gas as at present, and 20 lbs. would mean about 16 times as much. If our distribution systems could, without replacing, be made to distribute from 8 to 16 times more gas than at present, by comparatively simple and inexpensive additions and means, and without substituting large, new pipe, is not the idea well worthy of consideration?

Various reasons to the contrary no doubt occur, especially to those who are ever satisfied with present practice and who usually bring out objections to any proposed new departures. Enormous leakage, danger, loss of candle power due from compressing, the expense of individual house governors and the expense of the compressing machinery are all reasons that no doubt come to mind.

As stated, I have not had time to investigate at all the details of my subject. I can only give my ideas in general as they so far exist, without having as yet fully satisfied myself on some of them. For instance, I have not been able to ascertain the loss in candle-power resulting from compressing ordinary gas, to say, 20 lbs., and am thus unable to say either to you or to myself what that loss would amount to in dollars and cents on this feature of a high pressure proposition. My impression is that the loss with moderate compression, say to 20 lbs., —but 10% of Pintsch practice—would not be a material point, and could be compensated for by a little greater enrichment, and that the point would not stand in the way if other points were right. Nor have I had a chance to ascertain the cost of compressing machinery, and of figuring its operation as against the interest on the investment of larger mains. The balance, however, must be far in favor of compressing, as the cost of a suitable exhauster for drawing gas from the holder and forcing it into the mains at a few pounds pressure (or of such a compressor as is used for air compression or by the Pintsch people) would be but a fraction of the cost of changing a system of gas mains to the sizes sufficient to handle several times present capacity. In these days of delicate regulation and governors it further does not seem to me the governing of such pumping outfit should be a very difficult problem.

FIG. 5.—VIEW AT ROCKY POINT, ON THE WHITE PASS & YUKON RY.

The leakage question to my mind is a more immediate one, especially in connection with existing leaky mains. To put a great many times more pressure on such would first require the overhauling of practically every joint, which expense of course would have to be figured against the proposition. But it is probably truthful to say that a majority of gas mains at large would no doubt be a good deal better for an entire overhauling, and when once done—in a manner to be suggested—the work would be done practically for all time. My idea is that, to make a present system tight for high pressure, it would be desirable and necessary to inclose each hub and spigot joint with a special fitting in the nature of a light cast-iron sleeve made in two pieces, which could be bolted on to the pipe and envelope the joint, using a cement at the contact points for tightness, the original hub and spigot joint maintaining the strength of the main and the sleeves serving only to prevent the escape of joint leakage. To get at the joint would be easy, by simply unbolting and detaching such enveloping sleeve. With a new street main system, designed for high pressure, I should be tempted to use wrought-iron pipe with screw joints and thus, in the simplest way, get tightness and insurance against leakage. I at once hear objections to the use of wrought-iron pipe by those who are not in favor of such material for underground work. I think, however, that in view of the satisfactory experience had with wrought-iron pipe by natural gas companies on a very large scale, it is time that some of our former views on this point be somewhat modified.

While it is customary for many of us to say that it "rusts out" and should not be used, the fact remains that, in, I think, the majority of cases, it does not rust out to the degree looked for in theory or hoped for by opponents, but remains pretty tight and sound and all sufficient for its purpose for very many years. Certainly a number of gas companies of the best standing use it freely. If I am not mistaken, the Standard Gas Co., of New York city, uses it entirely, and, as I am informed, with result of having a lower leakage account than any of the other New York companies. Certain it is that miles and miles of it are used by the natural gas people with apparently all sufficient satisfaction. I have seen some such pipe dug out after 12 to 15 years' service that looked as though it had just been put in the ground. I believe that (if well coated and laid with some judgment as to locality and nature of soil), ordinarily speaking, it will last a generation, and until the company can afford to replace it, or it has to be replaced by pipes of larger capacity. I certainly believe it to be preferable to cast iron for any high-pressure system.

For those, however, who disagree with me and who would put in cast iron, it is undoubtedly possible to make a system tight in these days with cement joints; and, moreover, a system that will stay tight, short of absolute fracture. The lowest leakage accounts of which I have knowledge to-day are on systems made with cement joints. Lead joints, of course, are good, and will hold any pressure, but they will not stay tight.

A principal objection to high pressure, no doubt, is that of increased danger in the event of broken pipes and

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*Slightly condensed from a paper read before the Western Gas Association, at Milwaukee, in June, 1899.

†Philadelphia, Pa.

leakage. Undoubtedly that objection has some force. However, it does not in practice seem to stand in the way of distributing natural gas, which is likewise highly explosive, and less apt to be noticed in the event of leakage because of its lesser odor. It does not stand in the way of handling Pintsch gas at pressures of some 200 lbs. through ordinary mechanical devices and equipment and fittings in the immediate vicinity of many people and under the most trying conditions. As far as pipe and fittings go, those which will hold steam, natural gas, water, ammonia, Pintsch gas and other such fluids at high pressures, will certainly equally well hold illuminating gas if desired. The pipe system can be made tight all right enough, and will stay so to a reasonable degree. It is true, occasionally accidents may happen, as in running anything at high tension or pressure, precisely as the high speed of railroad trains, the high voltage of electric currents, the high pressure of natural gas, etc., at times lead to accidents that are serious. But high pressure has not stood in the way of development, and in almost every business will usually be found accompanying a better service than before to the public and a cheaper operating expense to the company.

FIG. 3.—BEGINNING WORK ON FISK'S CUT, TUNNEL MOUNTAIN; WHITE PASS & YUKON RY.

It would not be my idea to have any higher pressure than at present in the houses of customers; only in the streets and service pipes. I would expect to insert a regulator ahead of each meter to cut down from the several pounds pressure in the street to 15 or 17-tenths on the meter and house pipes, as at present. There are several regulators on the market that work perfectly well and dependably. They are not expensive. The repairs on them are practically nothing. The natural gas sections are full of them. The Pintsch and other railroad gas lighting systems use them universally, every day in the year, and get practically a perfect service.

On the question of cost, a company having, say, 1,000 customers, might equip them with regulators at an expense of $3,000 or $4,000. The interest on this investment is but $150 or $200 per year. Compare this with the cost of replacing from 10 to 25 miles of mains with sizes of pipe sufficient to distribute from 8 to 16 times more gas than at present, not forgetting the fact of avoiding the general opening of the streets, as well as the fact that with such regulators a vastly better individual service would be given than at present.

In a small way a tendency is developing towards pushing gas into street mains at higher pressure than what we call the ordinary. In several instances that I know of, and that no doubt will occur to you, a blower or pump creates a pressure on the mains higher than the holder pressure. Long Branch, N. J., forces gas to Red Bank and Spring Lake, using individual regulators to control the service along the line. No trouble is experienced. Johnstown, N. Y., is fed by gas at high pressure from Gloversville, N. Y., a few miles distant. Elizabeth, N. J., feeds Rahway, 6 or 8 miles distant. One of the Boston companies has a fan working directly on the street mains to increase the supply at certain times. New York has a run of 2 miles of pipe, I believe, under about 24-in. pressure. Philadelphia, for a while, forced gas 3 or 4 miles at something over 2 lbs. pressure.

These instances, as far as my knowledge goes, work all right, but at only ½ to 1 or 2 lbs. pressure. Why should not the practice be extended to 5 or 10 or 20 lbs. pressure and become general? In only one instance that I know of is high pressure used. That is at Danbury, Conn., where gas of 30 to 35 c. p. has, for several years, been pumped by a compressor under 40 lbs. pressure through a 2-in. wrought-iron pipe a distance of some four miles, to the town of Bethel where it is distributed (through a regulator from receiving tanks) in the ordinary manner to the extent of several million feet per year.

Discussion.

Mr. Runner—I have nothing to offer on the subject of pressure, but I have had some experience with the wrought-iron pipe and cement joints of which Mr. Shelton speaks. We have a wrought-iron pipe that was put down 33 years ago. It was coated with tar at the time it was laid, and this season we found it in as good state of preservation as it was the day it was originally buried. With cast-iron pipe laid with cement joints (and a sufficient number of lead joints to give room for contraction and expansion) we have not had a leaky joint up to this time, and we have so laid them for the past ten years. The pipe that was laid previous to this with lead joints is causing us constant trouble and annoyance. About every two years we have to get down to every joint and calk it. We have kept our unaccounted for gas down to 5.75% of the gas used.

Mr. Shelton—Before closing the discussion I want to speak rather more in detail about what is being done at Danbury: There is a compressor in the gas house at Danbury where the gas is made which forces the gas as made into the small 2-in. pipe which goes across country. That pipe leads into a stationary tank which is filled with gas up to 40 lbs. pressure. When that is filled they stop pumping. Twice in 24 hours they have to start the compressor up again to re-charge the tank. It takes a couple of hours to do it. They have no outlying holder; they have nothing to look after, except to go to that tank once a week and lubricate the valve. That is the sole attention required. I think a great feature in such a system is the absence of bother with the other end of the line. Everything is worked from the initial pumping station. They have no condensation to amount to anything. They put in drips along the line as a matter of precaution; and they go over those drips once or twice a year, but do not find anything. Everything that is condensable is "knocked out" of the gas during compression. They get that in the works. There is none of it in the tanks at the other end. The amount of drip at the works does not amount to a barrel per year. They have had no trouble with leakage. The pipe leaked a little bit at first and they had a check valve to keep the pressure off when not in use. They later made the pipe tight and now let it stand at high pressure all the time. They have had no trouble with naphthalene. They have had none of the theoretical bugaboos that the prophets predicted would crop out on high pressure delivery.

VITRIFIED CLAY PIPE INSTEAD OF IRON FOR GAS MAINS.*

By Irvin Butterworth.†

The idea of using vitrified clay pipes instead of iron or gas mains was proposed to me by Mr. Henry L. Doherty, President of the Madison (Wis.) Gas & Electric Company.

The proposition that ordinary vitrified clay pipes, similar to those now commonly used for sewer construction, can be readily substituted, with great advantage and economy, for wrought and cast-iron pipe for gas mains, appears, if not when first presented, then upon due investigation, to be entirely correct. While its correctness cannot as yet be proven by the citation of any examples of the successful use of vitrified pipes for gas mains, because such pipes have not as yet, to our knowledge, been employed, even experimentally, for that purpose; yet the apparent objections to the proposed system, that probably occur to some of you at first thought, disappear upon due consideration of the conditions to be met and the qualities of vitrified clay pipe.

The suitability of vitrified clay pipes for gas mains is due to its possession of the following properties:

(1) Cheapness; (2) durability; (3) strength; (4) non-susceptibility to electrolytic action; (5) slight susceptibility to changes of temperature; (6) non-porosity; (7) adaptability to the making of service connections by the use of specials or a small auxiliary distributing pipe of wrought iron.

We will consider these properties in the order named, and in comparison with those of iron pipe.

(1) Cheapness.—The following table shows the costs per foot of vitrified clay, cast-iron and wrought-iron pipe at present market prices:

Diameter, ins.	Vitrified clay.	Cast iron.	Wrought iron.
4	$0.04	$0.22	$0.35
6	0.06	0.35	0.65
8	0.09	0.46	0.98
10	0.13	0.62	1.50
12	0.17	0.81	1.92
15	0.25	1.19	(16-in.) 2.50
20	0.45	1.62	....
24	0.65	2.06	....

Vitrified clay pipes can be had, in quantity, in 4-ft. lengths, and with large and strong sockets similar to the bowls of cast-iron gas pipe, at approximately the above prices. The 4-ft. lengths would, however, necessitate the making of three times as many cement joints in a line of clay pipes as in a line of cast-iron pipes of the usual 12-ft. lengths. The following is, therefore, a rough but fair comparison of the cost of a mile of 6-in. vitrified clay and cast-iron gas mains:

	Fire clay.	Cast iron.
Excavating and refilling trench, at 25 cts. per ft.	$1,320	$1,320
Cost of pipe in trench, at 6 cts. and 35 cts. per ft.	317	1,848
Cost of making 1,320 and 440 cement joints, at 25 cts. each	330	110
Total cost	$1,967	$3,278

Saving in favor of vitrified clay pipes, $1,311, or 40%.

For sizes of main larger than 6 ins., the saving would be still greater, being, for instance, in the case of a 12-in. main, more than 50%.

(2) Durability.—Vitrified clay pipes are even more durable than cast iron. They do not rust or corrode. No chemicals or substances in the earth, foreign or otherwise, seem to attack them in the least. They are practically indestructible, and retain their strength and non-porosity indefinitely. I recently examined a piece of

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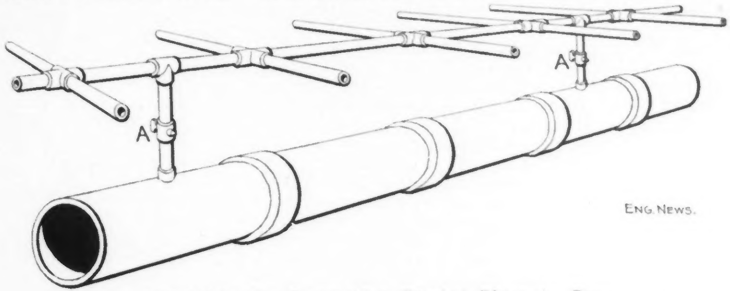
*Condensed from a paper read before the Western Gas Association, at Milwaukee, June, 1899.

†President Columbus Gas Co., Columbus, O.

vitrified sewer pipe that had been buried in the earth for 35 years, which, when cleaned, an experienced sewer pipe manufacturer said he could not distinguish, by appearance or any other test, from freshly made pipe.

(3) Strength.—Vitrified clay pipe, while not as strong as cast iron, is nevertheless amply strong for gas mains; as they do not break or crush when used for sewers, why should they do so when used for gas mains? The tensile strength of vitrified pipe, either fire clay or shale, is astonishingly great. Edward Orton, Jr., Professor of Ceramics at the Ohio State University, recently made some careful determinations of the tensile strength of vitrified clay pipe. He found that ordinary single-strength, 6-in., vitrified fireclay sewer pipes, with walls ⅝-in. thick, withstood an internal hydraulic pressure of from 90 to 120 lbs. per sq. in.; while 6-in. vitrified shale pipes withstood from 140 to 180 lbs., one piece not bursting even at the latter pressure. Twelve-inch, vitrified shale pipe, with walls 1¼ ins. thick, have withstood an internal pressure of 220 lbs. A 2-ft. length of 4-in. vitrified fireclay pipe, selected at random, with walls ½-in. thick, was supported at both ends, and a weight of 2,800 lbs. was suspended from the middle of the pipe before it broke.



Suggestion for Connecting Service Pipes to Proposed Vitrified Clay Gas Mains.

(4) Non-Susceptibility to Electrolytic Action.—Vitrified clay pipes are not in the least degree liable to injury from electrolysis; whereas, as is well known, the electrolysis of iron pipes has become a most serious matter.

(5) Slight Susceptibility to Changes of Temperature.—The relatively high coefficient of expansion of iron constitutes a serious objection to the use of this material for gas mains. Iron mains frequently break, and their joints generally leak, on account of the excessive expansion and contraction of the pipe, due to changes of temperature. On the other hand, the expansion and contraction of vitrified clay pipes, buried to the usual depths of gas mains, would be very slight indeed, and, in fact, practically nil. The following is a table of the coefficients of expansion of the materials named:

Steel	.0000068
Cast iron	.0000062
Glass	.0000039
Fire brick	.0000023
Common brick	.0000009

Although the coefficient of expansion of vitrified clay has apparently never been determined, it is safe to assume that, inasmuch as it partakes more nearly of the nature of common brick than of glass, its coefficient of expansion is no higher than the average of the coefficients of these two materials, or say only one-third that of cast iron. Substantially this view is held by Prof. Orton.

6. Non-Porosity.—Vitrified clay pipes are, except possibly at enormous pressures, absolutely impervious to gas, while cast-iron pipes are more or less porous at ordinary gas pressures. The vitrified clay pipes subjected by Prof. Orton to 180 lbs. of internal hydraulic pressure showed no trace whatever of sweating.

7. Adaptability to the Making of Service Connections by the Use of Specials, or by a Small Auxiliary Distributing Pipe of Wrought Iron.—It is probable that a successful method of tapping vitrified clay mains for services, and of connecting the services to the mains, would soon be forthcoming; but in laying new mains, especially the smaller sizes, it would probably be best to place a tee special in the line in front of each building lot, with a small side opening, pointing upwards, to receive the service pipe when needed and to remain plugged until then. Such specials for 4, 6 and 8-in. pipe would cost only about 18, 27 and 40 cts. each, respectively, and larger sizes in proportion. They would not, therefore, appreciably increase the total cost of the main, and the slight increase would not exceed the cost of tapping an iron main for an equal number of services. But it may be found or considered preferable, for the larger sized mains particularly, to place such specials long distances apart, say at street intersections only, and connect them with a small, say 2-in. wrought-iron pipe, placed a short distance and immediately above the clay pipe, and from which the various services would be taken.

This would obviate the necessity of specials in front of lots, or the tapping of the main. By placing stopcocks at the points A, and having suitable seals at proper intervals in the main, any portion of the main could be quickly isolated for tests or repairs, without interrupting for a moment the flow of gas in any of the houses supplied from it.

All things considered, there really seems to be no reason why vitrified clay pipes cannot be used, with satisfaction and great economy, for gas mains. There would appear to be no difficulty in making good, tight joints with cement, as the bowls can be made exactly like those of cast-iron gas pipe, with plenty of strength to withstand the calking in of the jute or other packing. We all know of gas plants whose cast-iron mains are laid with cement joints that do not break nor leak beyond the normal rate; cement joints can surely be successfully used on pipe of similar shape to the iron, and that expands and contracts only one-third as much.

Of course the vitrified clay pipe must be selected and laid with care, but not more carefully, as it seems to me, than cast-iron pipe, which is almost as nearly non-elastic, and which needs a firm and solid bearing throughout its entire length. The bottom of the trench should be scooped out to conform to the shape of the clay pipe, the earth should be thoroughly tamped around it, and a thin plank should be preferably laid over it to protect it from puncture by picks, etc. Lay the vitrified pipe as carefully as you lay the cast iron, and the breakage due to settlements will be no greater, while that due to expansion and contraction will be less, as will also be the leakage. It may be found best also to use "ring" pipe without sockets, and employ a pantaclinal, pitch, or other flexible joint. In any event, the possibilities for the reduction of the construction accounts of gas companies by the use of vitrified clay pipes instead of iron for gas mains seem too great and promising to be despised.

Discussion.

Mr. Shelton: I think Mr. Butterworth ought to be thanked for having brought out in practical shape a suggestion which is well worthy our consideration—even if it is in opposition to my own scheme. I am proposing to use smaller tubes and so save expense; he proposes to get right down to the bottom of economy, and to use cheap earth tubes! There is one point in which I do not agree with Mr. Butterworth, and that is where he makes the statement that "Cast-iron pipes are more or less porous at ordinary gas pressures." I cannot make myself believe that ordinary cast-iron pipe is porous under any pressure that we ordinarily put on it. I have seen half a dozen lengths of pipe packed full of gas under very heavy pressure, which remained just that way for weeks, yes, for months. If there had been any porosity that gas would have worked through, and the pressure gage would have shown a gradual fall in pressure. But the pressure stayed to the end as it was at the beginning, even fluctuating from day to day according to the temperature and the contraction and expansion inside; thus showing the absolute tightness of the pipe at that pressure with gas. The detail is a small one, but I did not like, by not mentioning it in passing, to let that statement go unquestioned. It seems to me the principal objection to the use of clay pipes would be their greater liability to breakage, under conditions of long span, occasioned in street work by sewer people, in laying conduits, and by other contractors working in the street. While by care and watchfulness, and by proper going over them in the first place, and with caution, that trouble can be very largely reduced, still I think that is one of the practical points that will have to be somewhat carefully guarded against. A short time ago, in the East, a proposition was made to manufacture glass pipe. I do not understand that anything was done with it, except to "put the company upon the market." Glass is, of course, a perfect protection against electric currents; it is clean, it is very strong, and, with proper machinery, a low grade could be made comparatively cheap. The service connections that I proposed as usable with that I imagine would also apply to sewer pipe connections. I proposed to make a small indentation every 3 ft. along the length of the pipe, with a boss around each, so that with a chisel one could break through the glass and could make a hole for the service connection. One could connect the service pipe at that point by putting in something like a nipple with lock nuts and washers or cement between. I will steal a little bit of Mr. Butterworth's thunder in winding up by saying that I have known clay pipe to be in use for gas down our way for some time.

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TESTS OF THE LAKE STEAMER "PENNSYLVANIA" FITTED WITH WATER-TUBE BOILERS AND MECHANICAL STOKERS.*

The "Journal of the American Society of Naval Engineers," for August, 1899, contains a report by Lieuts. B. C. Bryan and W. W. White, U. S. Navy, of a series of tests of the steam machinery of the freight steamer "Pennsylvania," recently put into service on the Great Lakes. The report is of unusual interest to marine engineers, for the reason that it is a record of a test of the first installation that has ever been made, so far as we are aware, of water-tube boilers fed by mechanical stokers on a steam vessel. The results of the tests appear to have been eminently satisfactory in every respect. After many years of experiment and struggle the water-tube boiler has now secured a sure foothold in the marine service, being now generally adopted in the most recent war vessels of many nations, and having made an excellent beginning in the merchant marine, especially in the freight steamers on the Great Lakes. The next improvement in marine practice, for which the world is waiting, is the introduction of mechanical stokers to feed these boilers. The advantages to be gained by their use, viz., saving of firemen's labor, burning of smoky gases and consequent saving of fuel are well known, and the results of the test indicate that there is no difficulty in operating them. The following is an abstract of the report:

The tests were made primarily for the purpose of observing generally the practical adaptability and working of underfed stokers (as manufactured and installed by the American Stoker Co.) to boilers of sea-going vessels, especially with a view to determining the economic results where (as was the case on the "Pennsylvania"), an inferior grade of slack coal is used. The particular coal handled on these trials was from the Essen mine in Western Pennsylvania. It contained a large percentage of refuse, and therefore afforded an excellent opportunity of illustrating any superiority in stoking which a mechanical device would give over hand-firing. A test of a sample of the coal used gave, by a Mahler bomb calorimeter, 11,790 B. T. U. per lb. of dry coal. Advantage was also taken of this occasion to ascertain the relative cost of operating all steam machinery installed as an integral or necessary part of the stoker equipment, and to measure the steam consumption of the main engine under various conditions, as well as to determine the economy of several of the independent auxiliaries.

General Description.—The vessel, which is of steel throughout, and recently put into active service, was built by the Cleveland Shipbuilding Co. for carrying freight on the Great Lakes. All hull plates are lapped and double riveted along the sides, and treble riveted at the ends. The framing is of channel bars. The upper deck alone extends the entire length of the ship, the interior of the hull being strengthened by longitudinals, beams and partial athwartship bulkheads. The engine and boilers are placed at the extreme after end of the vessel. One athwartship coal bunker is located immediately forward of the forward boiler-room bulkhead. Quarters for the crew are in the bow, and between these and the forward coal-bunker bulkhead the space is utilized for 13 large hatches, equally spaced, being provided for ease in loading and discharge. The principal dimensions of the hull are as follows:

Length between perpendiculars	430 ft.
Length over all	450 "
Beam (molded)	50 "
Draft, (deep)	18 "
Displacement, in tons of 32 cu. ft. at 18 ft. draft	10,155
Displacement, per in. draft,* in tons of 32 cu. ft.	49
Co-efficient of displacement—block	.83
Co-efficient of displacement—midship section	.85
Ratio to rectangle—midship section	.989
L. W. L. co-efficient at 16 ft. draft	.899
Double-bottom water-tight compartments	12

*At 14 ft. 6 ins. draft.

Engine.—The main propelling engine is of the vertical, direct-acting, inverted, jet-condensing, quadruple-expansion type, designed for a maximum horse-power of about 1,600. One piston valve, actuated by a Joy valve gear, is fitted on the side for each of the high, first and second intermediate-pressure cylinders. The low-pressure valve is a double-ported slide, placed on the after side of the cylinder, and operated by eccentrics and a double-bar Stephenson link. All cylinders are unjacketed. Cheapness in construction is a chief characteristic in the design of the main engine. The framing and bed-plate are of cast iron, and all principal bearings consist of a cast-steel or cast-iron shell lined with white metal. Brass for bearings, or in fact for any purpose, is avoided wherever practicable. The principal data of the engine are as follows:

Number of cylinders		4
Diameter of cylinders	H.-P.	15¾ ins.
	1st I. P.	23¾ "
	2d I. P.	36½ "
	L.-P.	56 "
Stroke		40 "
Diameter of piston valves	H.-P. (one)	12 "
	1st I. P. (one)	16 "
	2d I. P. (one)	22 "
Slide valve L.-P. double ported, ports 60 ins. long by 2¼ ins. steam and 4¾ ins. exhaust.		
Diameter of piston rods		4¾ "
Length of connecting rods (between centers)		9 ft.
Least diameter of conecting rod		5¼ ins.
Dis. bet. cylinder centers	H.-P. to 1st I. P.	3 ft. 8 "
	1st I. P. to 2d I. P.	3 " 8 "
	2d I. P. to L. P.	4 " 9 "

Order of cylinders from forward: (1) H.-P., (2) 1st I. P.,

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*Abstract of a paper published in the Journal of the American Society of Naval Engineers for August, 1899.

(3) 2d I. P., (4) L. P. Sequence of cranks: H.-P., 2d I. P., 1st I. P., L.-P. The H.-P. and 1st I. P. are at 180°, as are the 2d I. P. and L.P., the former being at right angles with the latter. There is a counterbalance on after crank web to balance extra weight of L. P. piston. The crank shaft is 11 ins. in diameter. Crank pins, 11½ ins. in diameter by 11 ins. long. Length of crank-shaft bearings (from forward), 16 ins., 16 ins., 16 ins., 22½ ins. and 16 ins. Thrust bearing, 5 horse-shoes; collars on shaft, 19½ ins. and 12 ins. diameter, 3 ins. thick, spaced 5½ ins. apart; after end of thrust has line-shaft bearings 11 ins. long. The stern bearing has one lignum vitæ bearing at after end, length, 3 ft. 6 ins. Total length of shafting in vessel, 48 ft. 7½ ins. There is one vertical jet condenser.

Boilers.—Steam is supplied by two boilers of the Babcock & Wilcox water-tube marine type, built for a pressure of 250 lbs. Each boiler is 9 ft. 3 ins. long, 12 ft. 6 ins. wide, and 16 ft. 8 ins. high, containing 3,000 sq. ft. of heating surface and suitable for 65 sq. ft. of grate surface.

Weight of boilers dry	145,860 lbs.
Weight of water contained	33,492 "
Total weight of boilers and water	179,352 "

Each boiler consists of 18 sections of straight, knobbled charcoal-iron tubes placed at an inclination of 15° with the horizontal, and expanded at their front and back ends into wrought-steel staggered headers. The front headers are connected at their upper ends to a steam and water drum, and at their lower ends to a blow-off connection or mud drum by tubes 4 ins. in diameter expanded into bored holes. All steam-generating tubes are 2 ins. in diameter, No. 10 B.W.G. in thickness, and 7 ft. 3 ins. long, the connecting tubes being 4 ins. in diameter and No. 6 B.W.G. in thickness. The sides of the boilers are formed by 2-in. tubes inclined the same as the generating tubes, but placed one above the other and expanded into straight manifolds or corner boxes.

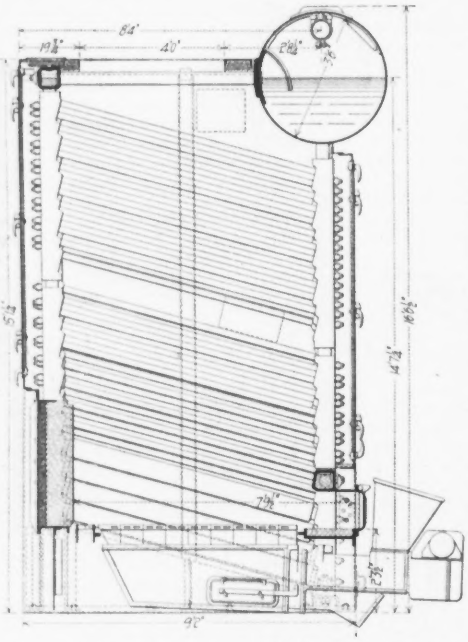


Fig. 1.—Water-Tube Boiler with Mechanical Stoker for Lake Steamer "Pennsylvania."

The Babcock & Wilcox Co., and the American Stoker Co., Builders of Boiler and Stoker.

The furnace sides are made up of four boxes of 5½ ins. square section, pressed from open-hearth steel plate ⅝-in. in thickness. They are placed at an inclination of 15°, and conected at their ends by means of 4-in. tubes to the corner boxes. These furnace boxes avoid the use of fire-brick side walls, and are of sufficient thickness to withstand the wear and tear of the fire tools. Brick work is used only in forming the bridge walls at the rear of the grate, which wall extends to the height of the lowest row of generating tubes.

All headers and boxes are made of open-hearth steel plate, welded after forming. As the headers are staggered, the tubes are placed in groups of four, each group being covered by a forged-steel elliptical band-hole plate, into which is welded a stud of 1-in. diameter, the plate being drawn to its seat by a forged-steel bridge and nut, and the joint made on the inside of the header against an elliptical faced seat by a thin lead gasket.

The steam and water drum of each boiler is 42 ins. in diameter and 14 ft. 10 ins. long over the bumped heads. The shell is of open-hearth steel 19-32-in. in thickness, the heads being ¾-in. in thickness. All longitudinal seams are butted and strapped, and have six rows of rivets.

Stokers and Blower.—Three mechanical underfed stokers* are fitted to each boiler. These were installed by the American Stoker Co., and each consists essentially of a central magazine, a coal hopper, a screw conveyor or worm, a wind box, cast-iron tuyeres or air blocks, and an independent steam motor for driving the conveyor shaft. The rate of feeding coal is controlled by the speed of the motor, which has a reciprocating piston working a cross-head to which is atached suitable link connections operating a rocker arm having a pawl mechanism actuating a ratchet wheel secured to the conveyor shaft. Coal thrown in to the hopper is continually fed by the conveyor or screw into the central magazine of the stoker, being gradually forced upwards, overflowing finally the tuyere blocks. Through these latter air is supplied by a blower, installed for the purpose, there being openings towards the central magazine, as well as on the opposite side. The gradual heating of the coal, in its upward course, releases the volatile gases, which are burned by air issuing from the inside of the tuyere blocks. A sort of coke is thus furnished to the dead grates at the sides of the stoker, the air for the combustion of which is supplies by openings on the outside of the tuyere blocks. No air enters from the ash pit. At the side of each stoker is located a cleaning door. Through these the fires on the dead grates are frequently sliced, and the non-combustible, in the shape of vitrified clinker, periodically removed. These doors provide means, also, of furnishing coal to the furnaces in case of accident to the stoker motors. The weight of each stoker complete, as fitted on the "Pennsylvania," is about 3,500 lbs.

Air is supplied to the wind boxes by one Sturtevant blower having a central duct with branches to each stoker. The fan is 60 ins. in diameter, 21 ins. in width at the periphery, and driven by a two-cylinder, simple, double-acting engine, with cranks at 180°; the cylinder diameters and stroke are, respectively, 5 and 4 ins. One piston valve controls the admission and emission of steam to both cylinders.

Description of Tests.—In all, eight tests of the main engine were made, of which the first five were each of six hours' duration. Those covered by tests No. 1, No. 2 and No. 5 (Table II.) are similar, and representative of the usual power developed under ordinary steaming conditions of the vessel. Test No. 3 was made with almost maximum HP. cut-off; test No. 4 cutting off very nearly as short as the HP. valve gear would permit. Tests No. 6 (a, b, c) of three, two and one hour duration, respectively, were undertaken with the sole aim of ascertaining the economy of the main engine when working under reduced boiler pressures. The economy of the engine, as shown by these tests, is not strictly comparable, one with another, on account of the irregular operation of the air pump, causing, as will be seen from an inspection of the tables, considerable variation in the vacuum obtained on the different tests. A more satisfactory comparison would have been possible had the vacuum carried been about the same at all times.

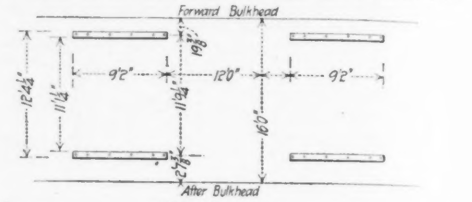
Previous to beginning the above tests the dead plates of the furnace fires were thoroughly cleaned of clinker. The same operation was repeated about an hour before each test ended, particular attention being given to have the fires, as nearly as could be judged by the eye, in the same condition at both the beginning and end. Each test was begun and finished with the stoker hoppers entirely filled; coal fired during the interval covered by the test was accurately weighed on a platform scales.

Apparatus for Weighing Feed Water.—During the tests all water fed to the boilers was delivered by the air pump, through a 5-in. pipe connection to the overboard discharge of the (jet) condenser, into the upper of two tanks in the engine room, which latter were specially inatalled for the tests. The upper tank was mounted upon platform scales, and water flowing into it could be regulated or shut off, as desired, by means of a valve. Each tank of water, after weighing, was dropped by gravity to the lower tank, from which a suction pipe, of about 8 ft. in length, led to the feed pump.

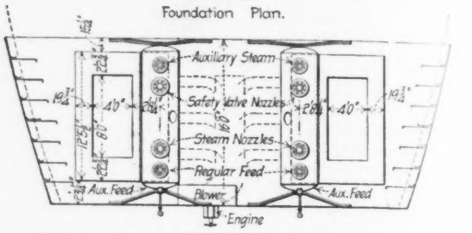
Graduated wooden scales were secured between the glands of the boiler water-gage glasses, and the height of water read at the beginning and end, and at hourly periods, as the tests progressed. A correction (amounting to 192 lbs. per in. of height) has been applied for differences of level in order to fix the true weight of water evaporated. All tests began with the lower or feeding tank full and ended in the same way.

Quality of Steam.—A Barrus throttling calorimeter, attached to the main steam pipe near the horse-power cylinder, was used to determine the quality of steam supplied by the boilers. The moisture in the steam, as figured, after making due allowance for condensation in the instrument, was so infinitesimal as to be entirely negligible in the final results. The assumption was made, therefore, that dry steam was furnished during all the tests.

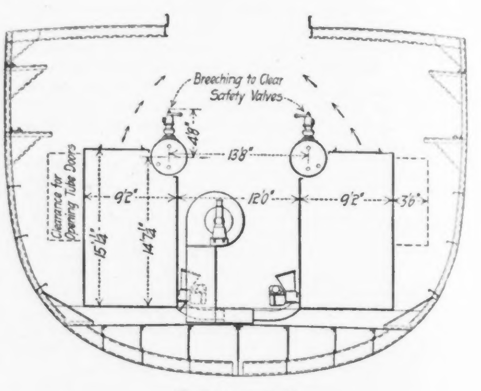
Steam Used by the Auxiliaries.—The method adopted to determine the amount of steam used by the auxiliary machinery was to condense the exhaust steam therefrom and weigh the resultant water. This condensation was accomplished by means of a cylindrical exhaust feed-water heater, of the surface-condenser type, containing 38 2-in. tubes 9 ft. long. The feed water, on its path to the boilers, passed through these tubes and condensed the exhaust steam from the auxiliaries, which was directed into the shell, and at the same time elevated its own temperature proportionally. In order to reduce the temperature during the tests, the drain from the shell of the feed heater was led to a coil contained within a barrel, into which latter a stream of water from the outside ran and overflowed into the bilge. A second barrel, mounted upon platform scales, finally received, by gravity, the condensed exhaust steam of the auxiliaries. As soon as the weighing barrel was filled, the inflow was momentarily stopped, the weight taken, and then the condensed water rapidly discharged into the bilge. The arrangement of piping was such that the feed could be by-passed around the heater if desired. A communication was also provided for atmospheric exhaust by a suitable connection and valve, fitted between the heater shell and escape pipe.



Foundation Plan.



Sectional Plan.



Transverse Section.

Fig. 2.—Cross-Section and Part Plan of Hull, Showing Position of Boilers.

In touching upon the feed water, it may not be irrelevant to note the course of the feed water after leaving the heater. Instead of being delivered directly therefrom to the boilers, it was led to two horizontal cylindrical purifiers, one for each boiler, situated above and near the back of the latter. These purifiers contained settling pans for the removal of the impurities and scale deposits, and here the feed water was further heated by the ingress of live steam before finally entering the boilers.

On May 28 three tests were run with the view of fixing the steam consumption of the fire-room blower and air pump, and incidentally the total steam necessary to operate the several auxiliary pumps and steering engine, which were in use during all the tests.

From the results of these tests, and a careful examination of the total and hourly condensed exhaust steam collected and weighed, the speed and auxiliary machinery in use, a close approximation to the average steam consumption per hour of each auxiliary was found to be as follows:

Auxiliary.	Steam consumption per hour, lbs. Table I.	Table II.	Table III.	Table IV.
Air pump	721	715	828	613
Feed pump	487	468	595	350
Bilge pump	275	275	320	240
Water-service pump	146	154	156	150
Auxiliary pump	330	...	...	...
Starboard dynamo	...	480	480	...
Port dynamo	671	...	...	...
Steering engine	125	125	125	125
Fire-room blower	622	692	725	550
Total	3,377	2,909	3,229	2,028

Test of Stoker Motors.—To determine the amount of steam used in operating the stokers, the exhaust from one

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*Descriptions of this type of stoker were published in Engineering News of July 25, 1895, and Jan. 2, 1896.

TABLE I.—Showing Auxiliary Machinery of Steamer "Pennsylvania" Independent of the Main Engine.

Number.	Purpose.	Make.	Type.	Diameter of cylinders, ins. H.-P.	L.-P.	Water.	Stroke ins.
1.	Main air pump	Blake	Vertical, compound, simplex	7½	12	20	16
1.	Main feed pump	Blake	Horiz., comp., duplex, plunger	6	10	5	10
1.	Auxiliary feed pump	Deane	Horizontal, duplex, plunger	..	8	4	10
1.	Bilge pump	"	" compound	4	7	6	10
1.	Water-service pump	"	" "	4	7	6	10
2.	Ballast pumps	"	" " duplex	8	12	16	18
1.	Deck pump (forward)	"	" duplex	..	5¼	3½	6
2.	Dynamo engines	Buffalo Forge Co.	Vertical, single-cylinder	..	6	..	6
1.	Steering engine	Cleveland S. B. Co.	Horizontal, 2-cylinder	..	7	..	7
1.	Windlass engine (aft)	Cleveland S. B. Co.	" "	..	..	..	..
1.	Capstan engine (forward)			..	..	..	..
5.	Deck winches	Cleveland S. B. Co.	Horizontal, 2-cylinder	..	..	..	..
1.	Blower engine	Sturtevant	Vertical, 2-cylinder	..	5	..	4
6.	Stoker engines	American Stoker Co.	Horizontal, 1-cylinder	..	6	..	4½

was led into a barrel containing a previously weighed quantity of water and there condensed. Two tests, similarly made, gave 22.5 and 23.7 lbs. respectively, or an average of 23.1 lbs., as the hourly consumption. For all stokers the steam used per hour would, therefore, amount to 138.6 lbs.

The cost of operating all stokers and blower, based on the results, is found to be 4.29% of the total steam generated. By reason of the blower exhaust passing through the feed heater, however, the actual net cost of the stoker installation is equivalent only to 1.68% of the steam made.

Flue Gases.—The temperature of the gases, just after passing the dampers in the uptakes, showed, on several tests, an average of 75° higher than that indicated at the base of the stack.

Practical Working of Stokers.—During the entire trip the stokers worked satisfactorily. The coal, as before stated, was a cheap grade of slack. Fires on the dead grates were sliced at about 20-minute intervals, at which periods, also, any loose clinker was removed; each fire received a thorough clinkering and cleaning every six hours. The steam required at all times was generated without difficulty, and, no doubt, with greater ease and economy than if hand firing had been employed. Only an extremely light smoke was observable during the ordinary working of the stokers. Practically, it may be said, the coal was burned smokelessly, except when the cleaning doors were opened, either for slicing or clinkering. At such intervals considerable smoke issued from the stack. A successful trial was made with the stokers stopped (blower running), demonstrating the feasibility of feeding the furnaces by hand, coal being supplied through the cleaning doors.

Conclusion.—Engine.—From the results of these tests it is apparent that the steam consumption of the quadruple-expansion engine of the "Pennsylvania" shows no economical gain over ordinary engines of the triple-expansion type as now designed for pressures approaching 250 lbs. Several assignable reasons may be advanced as accounting for this. It is probable, however, that the most cogent factor lies in the ratio between the first and final cylinders, which should have been larger for economical working at the horse powers developed at the usual speed of the vessel.

Auxiliaries.—The prevalent custom on vessels engaged in traffic on the Great Lakes has been, until recently, to attach all necessary auxiliary machinery operated in connection with the main engine (air, feed, bilge and water-service pumps), directly to it. Although not so convenient or satisfactory in many respects as compared with independent auxiliaries, this plan has unquestioned advantages in steam economy. With the general introduction of water-tube boilers, however, and the consequent practical necessity for independent feed pumps, which, in turn, led to the installation of feed-water heaters, the loss in economy within limits due to independent auxiliaries has been largely overcome.

As before stated, all auxiliaries on the "Pennsylvania" are independent. Those that run regularly when the main engine is in operation, viz.: air, feed, bilge and water-service pumps, are of the compound type, and show fair economy in steam consumption per unit of power. The economy of other auxiliaries, except fire-room blower, dynamo and steering engines, is unimportant, since they are only periodically in operation and generally for small intervals of time.

Of the auxiliaries above mentioned, the dynamo engines—each of which consists of a single cylinder with piston valves—are apparently the most expensive in steam per I. HP. developed. It is to be noted, too, that the tests show considerable difference in the economy of the port and starboard engines when carrying about the same load. This, no doubt, is attributable to steam blowing directly into the exhaust from faulty fit of the port engine piston valve.

During the experiments the effect of increasing the temperature of the feed water to about 225°, or above, in the heater, was noticed to be detrimental to the efficient action of the auxiliaries. At such times, on account of the excessive back pressure in the heater shell, much readjustment of the auxiliaries' throttles was required, causing "kicking" of the various pumps, and necessitating constant care. The upper limit of feed-water heating for thorough efficiency on the "Pennsylvania" seems to be about 200°, amounting to an average rise in temperature of the water taken from the hot well of, approximately, 95°. From the tests it is seen that this result is accomplished with the auxiliaries consuming about 10.5% of the total steam generated by the boilers. The cost, therefore, of operating independent auxiliaries in connection with an exhaust feed-water heater, as compared to attaching them to the main engine, when the above percentage is not exceeded, is only trifling, and more than offset by the many obvious advantages of independent machines.

TABLE II.—Summary of Tests of Machinery on Steamer "Pennsylvania."

Number of test	1	2	3	4	5	6a	6b	6c
Date (1899)	May 28[1]	May 30.	May 30-31.[2]	May 31[3]	June 1[4]	June 1.		
Duration of test, hours	6	6	6	6	6	3	2	1
Average boiler pressure, gage	242.0	244.2	240.8	245.3	245.0	197.4	129.8	108.3
Main engines: Steam pressure at engines, gage	239.4	238.1	237.2	241.8	241.8	193.4	125.8	104.3
Vacuum, ins.	24.35	23.56	22.73	22.71	23.67	23.40	21.60	21.16
Cut-off in H.-P. cylinder	0.644	.658	.798	.542	.656	.656	.656	.656
M. E. P. reduced to L.-P. cylinder	31.48	31.70	36.93	26.24	32.01	25.71	15.59	11.87
Revolutions	77.33	74.45	79.44	66.31	73.74	67.10	51.02	44.93
I. H.-P.	1,206.71	1,169.77	1,455.04	862.78	1,168.88	855.87	394.94	264.89
Feed water: Avg. temperature leaving heater, °F.	222	213.2	219	226.5	181.5	200.1	217	218
Total lbs.: Fed to boilers	122,439	116,136	146,089	89,566	98,026	45,937	18,390	7,615
Used by main engines	103,509	100,167	125,711	76,351	.....	38,818	13,630	5,303
Used by auxiliaries and stoker engines	18,930	15,969	20,378	13,215	.....	7,119	4,760	2,312
Lbs. per hour—main engines—total	17,252	16,694	20,952	12,725	.....	12,939	6,815	5,303
Main engines—per I. HP.	14.30	14.27	14.40	14.75	.....	15.12	17.26	20.02
Auxiliaries—total	3,155.0	2,661.5	3,396.3	2,202.5	.....	2,373.0	2,380.0	2,312.0
Per I. HP. developed by main engines	2.61	2.28	2.33	2.55	.....	2.77	6.02	8.73
Total per I. HP. developed by main engines	16.91	16.55	16.73	17.30	16.77	17.89	23.28	28.75
Exhaust steam actually sent to feed heater*	14.78	13.02	13.08	13.83	.....	10.59	17.41	18.79
Total steam used by aux. mach'y in operation, %	15.46	13.75	13.95	14.75	.....	15.50	25.88	30.36
Coal: Total, lbs.	14,400	14,200	18,000	11,800	14,750	.....	.....	.....
Per cent. of moisture.	3.3	3.3	3.3	3.3	3.3	.....	.....	.....
Total, dry, lbs.	13,925	13,731	17,406	11,411	14,263	.....	.....	.....
" dry, per hour, lbs.	2,321	2,289	2,901	1,902	2,377	.....	.....	.....
" " per hour for I.HP. for main engines	1.63	1.69	1.72	1.88	.....	.....	.....	.....
" " per hour for all machinery in use	1.92	1.96	1.99	2.20	2.03	.....	.....	.....
Refuse: Total	2,183	2,575	3,800	2,463	.....	.....	.....	.....
Per cent. in dry coal	15.68	18.75	21.83	21.58	.....	.....	.....	.....
Water evaprtd, pr lb.: Dry coal—Actual conditions	8.79	8.46	8.39	7.85	8.25	.....	.....	.....
" " " From and at 212°	9.24	8.97	8.85	8.21	9.02	.....	.....	.....
" " Combustbl.—Actual condit'ns	10.43	10.41	10.74	10.01	.....	.....	.....	.....
" " " From and at 212°	10.96	11.03	11.32	10.74	.....	.....	.....	.....

*Given in per cent. of total steam used for all purposes.

[1] Preliminary tests; weight of coal used unreliable. [2] Auxiliary water exhausted to atmosphere by blower equal 432.8 lbs. [3] Leak around gland of feed pump during test equal 396 lbs. [4] Total feed water weighed only during five hours of test.

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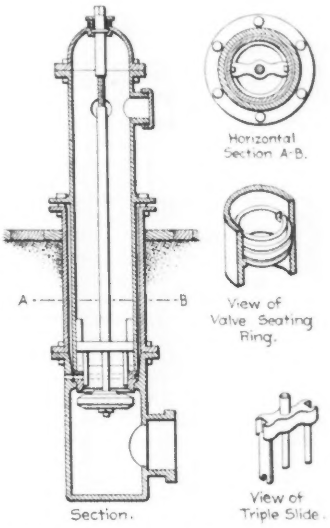
THE CAYUTA FIRE HYDRANT.

The fire hydrant here illustrated was patented on Aug. 22, 1899, and is made by the Cayuta Wheel and Foundry Co., of Sayre, Pa. Aside from the removable standpipe, for enabling the valve to be reached without digging up the hydrant, the chief claims made are as follows: The automatic adjustment of the valve in its seat; an improved drip-device; the ability to turn the fire-nozzle in almost any desired relation with the main, and an arrangement of parts that does away with receptacles for water in the interior and the consequent danger from freezing.

The valve is operated by the usual stem; but instead of locating the bearing and stuffing-box in the standpipe, these are connected with the dome or top of the hydrant, and the standpipe is practically unobstructed. This arrangement does away with the liability of forming pockets for water in the standpipe itself, and permits complete drainage. To assist in the automatic and accurate centering of the standpipe, as this enters the casing, the bore of the latter is made tapering at the bottom, with a rib forming a support for the valve-seating ring. This ring is a separate member, projecting below the rib mentioned, and is provided with a valve-seat, as shown; when the valve is closed this ring may be withdrawn with the casing and replaced, when necessary, without other expense. The standpipe and casing are connected by the usual flanges and bolts; but the bolt-openings register so that the standpipe and its nozzle can be turned in any desired relation with the main; and the operation of the flange-bolts forces the standpipe down upon the valve-seating rings and binds this firmly between the standpipe and the casing rim. As dust might enter the casing through the considerable opening between the flanges, the casing-rim is sloped inwardly and made slightly concave, to fit a similar rounding in the valve-seating rim. This formation tends to shed any dirt down into the lower part of the casing, and also provides a rocking-joint which ensures a close contact of parts, even when the standpipe is drawn slightly out of the perpendicular by the flange-bolts.



An Improvement in Fire Hydrants.
C. E. Loetser, Inventor; Cayuta Wheel & Foundry Co., Sayre, Pa., Manufacturers.

Above the plane of the valve the stem is provided with a crosshead which is fitted with terminal notches engaging in vertical guides formed on the interior of the standpipe. Below this crosshead, and inside of the valve-seating ring, is a collar which is also notched to fit the guides referred to. This construction interlocks the standpipe and this ring, and enables the latter to be turned with the standpipe. To drain the standpipe a continuous drip-channel is formed around the valve-seating ring, connecting with one or more openings through the casing itself; and the advantage of the several outer openings over a single one through the casing, is that if any one is accidentally closed by dirt or tree roots, the others come into play. Attached to one end of the crosshead, and moving with it, is a slide, which closes the drip-port when the valve is open, and opens it to drain the standpipe when the reverse is the case. This cut-off slide is so arranged that even a slight movement of the valve-stem shuts the port and thus prevents the escape of water under pressure to the outside of the casing, with the possible result of undermining the hydrant.

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

The fact that new rails make a roadbed more noisy in operation than rails which have been in service long enough to be worn smooth, was referred to by Mr. Allen Stirling, M. Am. Inst. M. E., in a recent discussion upon the advantages of heavy rail sections before the American Institute of Mining Engineers. We quote his remarks as follows:

> When the elevated railroads in New York city began to be operated, the noise from the rails was terrible—so bad that I, as the superintendent, was called before the Grand Jury to answer the charge of maintaining a nuisance, and narrowly escaped an indictment for that offence. Those who resided here at that time must remember the extraordinary noise produced by our trains in passing over the elevated structure. But this noise gradually subsided; and we got in many quarters the reputation of public benefactors, for having skillfully abated the nuisance; whereas, in fact, the amelioration was largely due to the smoothing of wheels and rails by use. Our rails were rough when new, and so were our wheels (though they were steel-tired Allen wheels); but the effect of daily wear upon both was a marked improvement in this respect.

Many of our readers who witnessed the operation of the Intramural Elevated Railroad at the Chicago Exposition in 1893, will recall how extremely noisy it was, and doubtless similar experiences will be recalled in connection with the opening of other roads. We do not recall, however, that this effect of the smoothing of the rails by wear has ever before been noted in technical literature.

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Far greater progress seems to have been made in the manufacture of gas and the utilization of its by-products than in its distribution. Two plans designed to reduce the cost of distribution were presented at the recent Milwaukee meeting of the Western Gas Association. Mr. F. H. Shelton, of Philadelphia, suggested that the gas be distributed through smaller mains, by using higher pressures, while Mr. Irvin Butterworth, of Columbus, O., elaborated a proposal made by Mr. Henry L. Doherty, of Madison, Wis., to substitute vitrified clay for iron gas mains. The two papers, slightly condensed, are reprinted in this issue. The use of smaller mains and higher pressures seems to be better supported, both by precedent and argument, than the substitution of clay pipe. The difficulty of making tight sewer pipe joints is only too well known by those engaged in municipal work. To be sure, ordinary gas pressures are very low, but the serious trouble frequently experienced with the infiltration of ground water through sewer pipe joints suggests difficulties from that source besides the possibility that in dry weather gas would escape, where water had been flowing in during wet weather. Then, too, sewer pipe breaks easily and is not readily tapped for service connections. The plan of a wrought iron rider or feed pipe for services lessens this objection, but adds quite materially to the expense. In fact, if the rider or feed pipe of wrought iron is to be provided, why not make it of a little better quality, if need be, and perhaps a little larger, and put it under pressure, as Mr. Shelton suggests? One of the objections most likely to be raised to the small mains and higher pressures is the increased leakage which might result; but it seems quite possible to decrease rather than increase the leakage, simply by putting a part of the cost of the larger pipe into a high class of joints for the smaller one.

It is no easy matter to get a tight lead or cement calked joint, especially on the larger sizes of pipe, but with smaller pipe, wrought iron might perhaps be used exclusively, with screw joints, supplemented by special measures to prevent leakage, if deemed advantageous.

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As most of our readers will have learned from the newspapers by the time this issue reaches them, the sentence of Captain Carter was approved by the President on Sept. 29. The official statement of the sentence corresponds substantially with that already published in these columns, viz., five years' imprisonment, $5,000 fine, and dismissal from the army, with the publication of the details of his crime and punishment in the papers "in and about the station and the State from which the accused came, or where he usually resides."

We commented so fully upon this case in our issue of Sept. 7, that it is needful to say little more at this time. The attempt on the part of Carter's attorneys to mislead the public into the belief that their client is an innocent victim of persecution has failed, as it deserved to fail. He has had every opportunity to clear himself, first, before a board from his own corps, and later, before a general court-martial; and the delay in the execution of his sentence, and the patient hearings given by the President and his advisers to repeated appeals from his attorneys for a disapproval or revision of his sentence, have been such as have never been before extended to any culprit after conviction by a court-martial in the whole history of the Government.

Regarding his letter, which was published in these columns last week, it seems needful to add one comment to those already made. His slurs against his successor, Captain Gillette, and his former assistants, Messrs. Gieseler, Twiggs and Cooper, deserve severe condemnation. These men are all engineers of intelligence, ability and reputation. They had nothing whatever to gain by the testimony which they gave against Captain Carter. On the contrary, Captain Gillette, in particular, put at risk his own reputation and official position; for had the prosecution failed to convict Carter there can be no manner of doubt that that officer, with his wealth and influence and wide circle of friends, would have been able to retaliate most effectively. Captain Gillette has performed a very hard, disagreeable and dangerous duty, in whose performance there was neither glory nor the hope of reward, and he deserves public credit for it. Many an engineer in a similar position would have turned back from such a task and argued that it was none of his business what his predecessor had done. It is fortunate for the country that Captain Gillette did not take that view of his oath to defend the United States and its interests. The prosecution, which was initiated through his disclosures, and whose final result we have just recorded, has cleared the air. Captain Carter's fall is a salutary warning to every man in a similar responsible position not to dally with temptation; and as we said in our issue of Sept. 7, we repeat: that it would be a gain for civilization if every man accused of falsity to trust could be tried by a court so competent to sift evidence and determine the truth as that which passed upon the case of Captain Carter.

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A COMPARISON OF HAND AND MACHINE PRODUCTION

In 1894 a joint resolution was passed by Congress authorizing the Department of Labor to undertake an investigation of the effect of the use of machinery upon the cost of production, and of the relative productive power of hand and machine labor. The results of that investigation have just been turned out of the Government printing office in the shape of two bulky volumes, in which, it is safe to say, is presented a far greater fund of information upon this subject than has ever before been gathered.

In the original resolution, the Commissioner of Labor was requested to ascertain the effect of machines operated by women and children upon rates of wages, and also as to whether changes in the cost of production are due to a lack or surplus of labor or to the use of labor-saving machinery. Commissioner Wright, in his report, however, points out that statistics can give no direct answer to questions of this class, and confines his effort to showing what machines have done to reduce the cost of production.

At the outset, it is explained that the terms "Hand" and "Machine" production are not used in their strict sense, since hand operations enter to some extent into even the most modern systems of manufacture; while all hand production, on the other hand, in even the crudest arts, is aided by the use of tools which are, strictly speaking, machines. What is really compared, therefore, is modern manufacturing methods with such methods as obtained in the days when work was performed by hand tools, and human skill and muscle carried on their daily task unaided by power-driven machinery.

Securing the data for the modern system of production was an easy task; but to obtain reliable data for hand production processes was very difficult. It was often necessary to hunt up employers or workmen who have now retired from active life, but had once been engaged in making the article in question by the old hand method, and to consult their recollections as to the methods used. The result, however, has been the collection of a great amount of information which a few years later it would be forever impossible to secure. It is a fact, not often realized, that it is the half-century now closing which has witnessed the displacement of hand by machine production. The "factory era," it is true, began much earlier; but at the middle of the century the old hand processes were still in use to a very large extent. It is since that time that the overwhelming superiority of machine production has been established, with the effect of driving the old hand processes entirely out of use. If, then, authentic data was ever to be secured regarding the old handicrafts which have now been abandoned, it had to be done during the lifetime of the present generation.

The investigation is classified under the heads of Agriculture, Manufactures, Mining and Transportation; but as would naturally be expected, the bulk of the work is devoted to manufactures. The saving of time in agriculture, however, is hardly less marked than in manufacturing operations. Thus to produce and harvest an acre of corn by the methods in use in the '50's is shown to have required 182⅔ hours of labor, as compared with 27 hours when the work is done by the machinery of the present day. An acre of wheat required 61 hours' labor in 1830, as against only 3 hours' labor in 1896. To harvest an acre of hay required 21 hours' labor in 1850, and only 4 hours' labor in 1895.

Turning to manufactures, we find a comparison of the old wooden moldboard plow compared with a modern iron plow. To produce one of the old-fashioned plows required no less than 118 hours of labor, while the modern plow costs only 3¾ hours. In the brick-making industry, handwork amounted to 20 hours per M., as compared with

7½ hours by machine. About the same proportionate saving was made in the manufacture of paving brick and of sewer pipe.

In the textile industries, 9-wire body Brussels carpet was woven on hand looms in 1850, with a labor expenditure of 4.04 hours per yd. The same carpet is now woven on power looms, with only a half-hour of labor per yd. Cotton sheeting was made from the raw cotton by hand in 1860 with 5,605 hours of labor per 500 yds. In 1897 a modern cotton mill turns out the same goods with only 52¾ hours of labor. A large part of the labor consumed in the modern process is chargeable to hand manipulations still in use. Taking up the different operations involved in the production we find the most remarkable contrast in the carding. Here the ratio of the carding machine to the hand cards was 4,140 to 1. In other words, it would require a man 1,980½ hours, or nearly 8 months, working 10 hours per day, to card the cotton for 500 yds. of gingham, while with machines he could do the same work in 28.7 minutes. In spinning, the ratio in favor of the machine was about 200 to 1; in reeling it was 350 to 1; in weaving, it varied in different mills from 11 to 1 to 30 to 1.

Turning now to manufactures of iron and steel, we find that files are now made with about one-third the hours of labor that were employed by hand workmen in 1872. A rifle barrel took 98 hours' time of a hand workman in 1857, and it is now made with 3⅔ hours of labor. Half-inch bolts 6 ins. long with nuts are made by hand at the rate of 500 in 43 hours, while by machinery the same product is turned out with only 8 hours' labor. In the manufacture of iron pipe, 100 ft. of 4-in. lap-welded pipe cost 84⅓ hours of labor in 1835, while the same product was turned out with less than 5 hours' labor in 1895.

In lumber manufacture, the old-time method was to saw the logs into boards with whip saws, a method still practised in some remote and inaccessible regions. To saw 100,000 ft. of white pine boards by this method in 1854 took no less than 16,000 hours of work. A modern saw mill turns out an equal product with a labor expenditure of but 273 hours. In 1813 iron cut nails were made by hand, with a labor expenditure about 130 times as great as that required to produce an equal quantity of cut nails in a modern factory.

In quarrying, the modern compressed air drill can put down 30 holes 18 ins. deep and 2½ ins. diameter in granite rock, with 14 hours, 50 minutes of labor. The same task would require 89 hours' labor with hand drilling.

From these few illustrations selected from the large number of industries covered in this exhaustive report, some idea can be gained of the great revolution which has come about in the civilized world during the past half-century through the spread of labor-saving machinery.

In studying the economic effect of this change, it must be remembered that the displacement of labor is by no means so great as appears on the surface, since the labor employed in making the machinery is not taken into consideration, and this partially offsets the loss of employment by some of those who were employed in the hand processes of production. Even with this correction made, however, the total amount of labor required to produce a given quantity of any product by modern machinery and methods is but a small fraction of that required by the old hand processes. If, then, the volume of production were a fixed amount, the demand for labor would be greatly reduced, and loss of employment, with its attendant suffering, would result, and has resulted in many industries. In most cases, however, the decreased cost of production consequent upon the introduction of labor-saving machinery has led through competition to a lowering of the selling price, and an increased demand for the product, which has so increased the volume of production as to make the final result a large increase in the total demand for labor. In this way, labor-saving machinery has benefited labor, for it has not only enormously decreased the cost of food, clothing, and of all the necessities and luxuries, but it has so increased the productive power of the laborer as to make possible the payment of higher wages than were ever dreamed of in the days of hand production.

In this connection, however, it is of importance to note that the benefit to labor, and, for that matter, to the world at large, from the use of labor-saving machinery can only take place if the selling price to the final consumer is reduced by reason of the diminished cost of production. If through the restraint of competition by the great modern aggregations of capital which are currently called trusts, the introduction of labor-saving machinery goes on without decrease in the cost of the product, it is apparent that there can be no increase of demand, and no new labor employed to offset that which is rendered idle.

Viewed in the large way, no intelligent man can doubt the enormous benefit that has accrued to all classes in all civilized lands through the progress of invention and the development of labor-saving machinery. It is equally true, however, that a fair share of the gain from all such improvements must be made effective in a reduction of the cost to the final consumer, or else the gain will only result in the enrichment of a single set of men, and in hardship and suffering to a much larger number through the loss of employment.

LETTERS TO THE EDITOR.

One Reason for the Great Consumption of Water by American Cities.

Sir: The enclosed clipping from the New York "Times" may interest your readers. This is the kind of thing that is going on beneath the soil on which we live. It is one case out of a hundred thousand, accidentally come to light. It is going on and continuing whenever water is not watched and measured, now as in the past. Thus it was in ancient Rome; thus it is along the banks of the Erie Canal, and in the streets and houses of Manhattan and other cities. Yours, H. C.

New York, Sept. 24, 1899.

(The clipping enclosed is given below. It reminds us of the statement made to us by one of the most prominent canal advocates to the effect that the canals could not be abandoned by the State because the people all along their lines had built up various industries which were dependent on the canal for water supply and water power. Such use of the State's water has been winked at so long that those who have practiced it have come to consider that they have a legal right to use the water, and the case cited below is an excellent illustration of this.—Ed.)

Surreptitious Use of Erie Canal Waters.—Mary L. Beekman and Samuel Beekman dug a ditch across the towpath of the Erie Canal in Montgomery Co., and thence down the embankment to their own lands adjacent to the canal, and laid a 2-in. pipe from the water in the canal for about sixteen feet and then connected a 1-in. pipe to the other and laid the latter in the ditch to their own lands, so as to cause the waters of the canal to flow through the pipe. They used the water thus obtained for irrigating and increasing the productiveness of their lands. Fred. Jones stealthily put a basswood plug into the mouth of the pipe, in the canal, and the plug passed on to the connection between the 2-in. and 1-in. pipe, swelled, and stopped further flow of the water. The Beekmans failed in their efforts to clear out the pipe until they got a hint about the plug. Then, digging at the connection of the pipes, they found and removed it. They were awarded $200 damages in their suit against Jones in the Justice's Court, but after appeal to the County Court the jury there gave them $100 damages. This verdict was set aside, and that decision has been affirmed by the Third Appellate Division in an opinion by Justice Landon. The court held that the canal, being owned by the state, the plaintiffs showed no right to the use of its waters. "Suppose A has a cow," Justice Landon said, "which B daily surreptitiously milks, and C maliciously kills the cow. No one would claim that B has a cause of action against C for depriving him of the supply of milk he was enjoying. The court does not lend its aid to a party who founds his cause of action upon his own illegal act."

Measuring the Mean Spherical Candle Power of Incandescent Lamps.

Sir: We notice in your account of a "Portable Photometer as Used in the Standard Oil Co.'s Tests," in the issue of Sept. 7, that you say:

> We would suggest that the machine could be provided with a rotary socket which could be set at any angle of inclination, thus making it easy to get the mean illumination in the corresponding zone in the same manner. In this way the mean spherical intensity could be arrived at.

While this would be desirable for purely experimental purposes, I wish to point out that such a method of measurement is not a practical one, nor one to be adopted in practice, for the following reasons:

The electric light is the only kind of light which can be burned in any and every position. All measurements of the candle power of gas and oil flames are made in a horizontal position, and to require that incandescent lamps be rated at their mean spherical instead of their mean horizontal candle power, as has been proposed by the National Electric Light Association, would work a great hardship on electric lighting and incandescent lamps, in imposing conditions not applicable to, or existing with, other forms of lighting.

From extensive tests, we find that the candle power at the 45° position is the mean of the horizontal and vertical readings. Where an incandescent lamp averages 16 c. p. mean horizontal intensity, it will measure in the 45° position only 12½ candles, which is a difference of 3½ candles. In other words, the present 16 c.-p. lamp, mean horizontal candle-power reading, would give only an average of 12½ candles on mean spherical candle-power rating. This means that to give 16 c. p. mean spherical rating, the mean horizontal candle-power rating would have to be increased approximately from 16 to 19½ candles. If the total watts of the lamp were not increased, this would mean producing a lamp having an economy of 2.64 watts per candle. Such a lamp is not commercially practicable, as we find that all genuine 2.5 watt lamps have an average life of less than 200 hours, and are too delicate to give satisfaction in regular service. The only other way to offset this difficulty would be to keep the economy of 3.1 watts per candle, and thus increase the total power consumed by the lamp from, say, 50 watts to 60 watts.

The foregoing, I think, is sufficient to show you the objections to mean spherical candle-power rating. I might say that to-day the mean horizontal candle power continues to be the accepted rating of incandescent lamps. Yours very truly, F. W. Willcox,

Asst. to Manager of Incandescent Lamp Sales,
General Electric Co.

Harrison, N. J., Sept. 26, 1899.

(As was pointed out in this journal some years ago, in the series of articles on systems of car lighting, the intensity of a source of light can only be correctly measured by determining its mean spherical candle power. Of course, when gas and oil flames are measured in a horizontal plane, makers of electric lamps have some reason in demanding that their product shall be tested in the same way. As a matter of fact, however, sources of light are almost invariably placed above the space or plane whose illumination is desired, and the mean spherical candle power must be found to determine the illuminating effect. The fact that the ingenious little photometer which we illustrated could be adapted to make the mean spherical intensity readily measurable appeared to us, therefore, of no small interest.—Ed.)

Continuous Blueprint Apparatus.

Sir: I have noticed the correspondence on the above-named subject in your issue of July 27 and Aug. 3 and 10.

Permit me to state at this late date that an apparatus for continuous blueprints working successfully was invented and patented by me in 1890. A machine was built and was operated by F. Mayer & Co., blueprinters, at 170 Madison St., this city. Numerous continuous prints were made by that firm for this office, the U. S. Engineer's office at Milwaukee, the Chicago Sanitary District and for a large number of surveying and engineering firms of Chicago and other cities. The prints turned out ranged in length from 8 ft. to 128 ft.; in width from 12 to 54 ins. All were made without difficulty, with absolute safety to the tracing, and of an even color, without "blurs" or "streaks." About two years ago the firm of F. Mayer & Co. dissolved, on account of the sickness of Mr. Ferdinand Mayer, who died a year later. Since then the machaine has not been used.

The apparatus consists of a cylinder, 30 ins. in diameter, revolving within a dark box, mounted upon a turntable, etc. The dark box also contains the gearing for operating the cylinder, two small receiving rollers for tracing and prepared paper, respectively, and a set of friction rollers for the purpose of maintaining a certain tension, and stretching tightly the tracing upon the paper and the cylinder. An aperture in the dark box exposes to the sun's rays a large part of the cylinder's face, upon which appears the tracing with prepared paper beneath. The open part of the box and cylinder within is now exposed; the cylinder being set in motion. Should the print desired be longer than the circumference of the cylinder, then the second layer of paper and tracing will cover up the first. An opaque trailing sheet fastened to the end of tracing prevents any part from being exposed twice.

After exposure (with the gearing arranged to release the cylinder), both sheets are extracted and the print is washed in the usual manner. The machine may be operated by hand or by electric battery and motor. A clockwork proved not powerful enough to overcome the friction and tension necessary for stretching tightly the tracing and paper upon the cylinder.

The objections raised by Mr. Rondinella over the "sectional apparatus" described by Mr. Kirchoffer were found to be correct, inasmuch as "buckles" are bound to form; or, in other words, the tracing will travel faster or slower than the blueprint paper, thus losing or gaining on the latter's coincidence, which is essential to correct reproductions. The apparatus described by Mr. Petithon, of Detroit, can hardly be called an apparatus for continuous prints, inasmuch as a cylinder of 6 ft. diameter must necessarily limit the length of print to about 18 ft., or the length of its circumference.

F. Mayer & Co. were also operating such a "loose" cylinder, precisely of 6 ft. diameter, hung in wyes and equipped with special devices for stretching tracing and paper. The work with this large cylinder, however, was always done with a good deal of trouble and danger to the tracing, and it therefore was abandoned.

I shall be pleased to furnish further information on this subject to parties directly interested.

Respectfully yours, Paul Heinze, C. E.
U. S. Engineer office, 1637 Indiana Ave., Chicago, Ill.,
Sept. 23, 1899.

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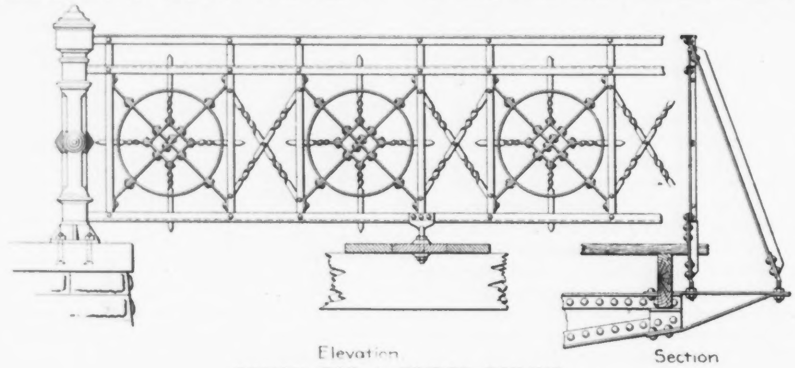
The Design of Ornamental Iron Work.

Sir: Referring to the article on "The Manufacture of Ornamental Iron Work," by Chester B. Albree, and your editorial remarks thereon, as published in the last issue of Engineering News. The methods of design and construction, described by Mr. Albree, are those in general use in shops building this class of work, and the use of special methods, tools, jigs and fixtures is well understood, especially where the work in hand requires a large number of interchangeable pieces. However, I do not believe that the use of special tools and jigs is confined to particular shops or to certain classes of work; I am convinced that the use of these has become general and they will be found in works employing but a few men, as well as in the largest manufacturing concerns. I hand you herewith a print showing a wrought-iron fence built by a prominent bridge concern, which I think is a good sample of the artistic design and construction advocated by Mr. Albree; that is, the use of ordinary rolled shapes. In conversation with one of the bridge company's engineers he informed me that they used some special tools of their own construction for forming the fence pieces and riveting the parts together, and they were thus enabled to turn out the work on a very satisfactory cost basis; this was several years ago.



DESIGN FOR A BRIDGE RAILING.

I have for years advocated the use of special tools and jigs wherever the product will permit their use, and believe the low cost of producing work in this country (where labor is high-priced) is due altogether to the adoption of such appliances. I have seen many ingenious devices in small machine shops that were born of necessity and permitted work being done at a profit that otherwise would have gone to a shop having a better variety of machine tools.

The production of such special tools and fixtures is of necessity based on a thorough knowledge of machine shop practice; and it is not plain to me how designing engineers and architects are to become practiced in their use, as Mr. Albree would have them, except by taking up the detail of shop work. So far as the use of rolled shapes is concerned, as entering into economical design, I believe that such as are now obtainable were first produced on suggestion from engineers, architects and manufacturers, and that these men are better posted as to their various uses than any others; especially is this true when it is considered that on them fall the burden of producing work at the lowest cost, the governing factor in most cases. The manufacturer's book of sections, giving all necessary data as to strength, carrying capacity, etc., is found on the table of every designer, within easy reach, and is generally used to the exclusion of other pocket books in the selection of shapes for the work in hand.

Mr. Albree's article has the merit of furnishing information of a general class to persons interested in the design and construction of ornamental iron work; and his criticism of designers may open up a discussion in your columns and thereby be productive of good to the fraternity generally.

I appreciate very much the notice in your columns of the partial abolition of water rents at Detroit and your comments thereon. I have advocated the same method for several years and have been trying to get this town interested. The scheme appears of easy solution, but like all new innovations meets with stro ng opposition, just like the opposition to Worthington's pumps when first put on the market, when it was remarked they "are 20 years ahead of time." Yours truly,

W. B. O.:horn.

Clarksburg, W. Va., Aug. 15, 1899.

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Early Compound Screw Propeller Marine Engines in the United States.

Sir: There seems to be many opinions entertained as to the first application of the compound engine to screw steamers in the United States, and also concerning the first foreign built vessel to arrive here having the compound engine. This type of engine was applied to four side-wheel steamboats for New York waters about 1825. These engines worked with a steam pressure of over 50 lbs. in their high-pressure cylinder. The compound screw propeller engine, however, is of much later date, and its history as commonly written is as much in error as the generally accepted tradition regarding the American beam engine, the history of which, I think, is yet to be correctly written.

I noted a few years since in an article by an able writer in one of our scientific magazines that the first vessels with compound engines for the transatlantic service to arrive in this country were the "Italy" and the "Egypt." To this I would take exception: First, because there was a screw steamer with compound engines in the transatlantic service several months prior to the vessels above named; and, second, because there were compound screw engines in American steamers built in this country before either of the three above-named vessels—all of which were foreign built—arrived in this country.

Referring to the arrival of steamers in the transatlantic service, I find that the "Italy," built by John Elder & Co., was launched March 25, 1870, and arrived at New York city on her first voyage July 25, 1870. The "Egypt" was not constructed until the following year. Both of these vessels belonged to the National Line, and are generally quoted as being the first compound engine steamers to cross the Atlantic Ocean.

The "India," built by W. Simons & Co., at Renfrew, Scotland, for the Anchor Line, with compound engines, two of 36×72×36 ins., arrived at New York city, Feb. 24, 1869, more than a year previous. This will establish the priority of arrival in this country of the "India" over the "Italy," for the regular transatlantic service.

There was, however, one vessel with compound screw engines earlier than the "India" by several years. I do not remember any of the marine engineers in later years—either designing or running engineers—who were in active service at that time referring to the vessel or her engines. It was none other than the first compound engine constructed by Randolph Elder & Co., in 1854, for the steamship "Brandon," whose hull was built by Barclay & Curle at Glasgow, and whose dimensions were 215 ft. × 25 ft. × 17 ft. The engines had four cylinders, two 41-in. and two 63-in., with 36-in. stroke, and having two cranks. This vessel arrived at New York city on Sept. 3, 1854, with freight and passengers from Southampton, and she sailed for Liverpool on Sept. 18, 1854, having been surveyed while lying in the port of New York. She was subsequently engaged in dispatch service during the Crimean war, and I have not been able to get any further trace of her.

As to the development of the compound engine, when applied to screw steamers in the United States, the first application was in 1864 by Norman W. Wheeler, engineer of New York city, in a steam yacht named the "Octavia." This vessel had double compound "Cricket" engines, the cylinders being 18 and 36 ins. by 18-in. stroke. This vessel was built for Mr. T. W. Kennard, then chief engineer of the Atlantic & Great Western R. R. This vessel was used by her owner more for scientific purposes than pleasure, mainly in New York waters and along the Atlantic coast. Little is known of the performances of these engines.

The American marine engine builders soon began to take hold of the new type of engine after the War of the Rebellion, but not on the Atlantic coast. It was left for the first application to be made to the merchant screw steamers on the lakes, under the Perry and Lay patents by the Patent Compound Engine Co., of Buffalo, N. Y., and the engines were first applied to steamers on Lake Erie. This engine was altogether different from those on the steam yacht "Octavia," being of the tandem type, with rotary valves, and communication between the cylinders through a pipe connection. The cut-off was a poppet-valve in the main steam pipe. In 1867 the engine of the steamer "Susquehanna" was altered to a compound from a simple non-condensing engine. During the next two years the engines of seven other steamers on the lakes were altered to compound; and during 1869 the first new engine constructed under this patent was erected in the steamer "Jay Gould," running from Chicago to Buffalo. It will thus be seen that the compound engine as applied to screw steamers was in service in American waters prior to the arrival in this country of any modern foreign-built compound engine screw vessel.

Yours, &c., J. H. Morrison.
358 Hancock St., Brooklyn, Aug. 25, 1899.

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Notes and Queries.

Our attention is called to a typographical error in the review of Tribe's "Compound Engines" in our issue of Sept. 14. "16.42 cu. ins." should read "1,642 cu. ins."

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STATISTICS OF RAILWAYS IN THE UNITED STATES FOR THE YEAR 1898.

The advance sheets of "Poor's Manual" of railways for 1899 have just been issued covering the construction and operations of the railways of the United States up to Dec. 31, 1898. As will be noticed, these figures cover railway operations for a period of six months later than the statistics of the Interstate Commerce Commission, published in our issue of July 20, 1899. The following extracts from the principal tables show some of the leading facts brought out by the figures given:

Mileage of railroads	184,894.33
Second track, siding, etc.	60,344.54
Total track	245,238.87
Steel rails in track	220,803.87
Iron rails in track	24,435.00
Number of locomotives	36,746
Cars: Passenger	25,844
Baggage, mail, etc.	8,049
Freight	1,284,807
Total	1,318,700
Liabilities.	
Capital stock	$5,581,522,858
Bonded debt	5,635,363,594
Unfunded debt	368,182,584
Current accounts	383,682,168
Total liabilities	$11,968,751,204
Excess of assets over liabilities	316,616,498
Total	$12,285,367,702
Assets.	
Cost of railroads and equipment	$10,256,275,585
Real estate, stocks, bonds & other investm'ts	1,594,565,979
Other assets	265,264,972
Current accounts.	169,261,166
Total assets	$12,285,367,701
Miles of railroad operated	184,532.61
Revenue train-mileage: Passenger	344,761,142
Freight	542,824,509
Mixed	17,424,581
Total	905,010,232
Passengers carried	514,982,288
Passenger-mileage	13,672,497,664
Tons of freight moved	912,973,853
Freight mileage	114,566,173,191
Traffic earnings: Passenger	$272,589,591
Freight	868,924,526
Miscellaneous	108,044,607
Total	$1,249,558,724
Net earnings	389,666,474
Receipts from other sources	104,536,904
Total available revenue	$494,203,378
Payments.	
Rentals, tolls, etc.	$62,740,145
Interest on bonds	237,133,099
Other interest	5,069,290
Dividends on stock	94,937,526
Miscellaneons	35,681,080
Total payments	$435,561,140
Balance, surplus	58,642,238

Summarizing some of the more important of the above items, and comparing them with the corresponding figures for 1897, the tables show the following results:

	1898.	1897.	P. ct. of inc., '98 over '97
Miles road operated.	184,532.61	181,874.07	0.14
Tons freight moved..	912,973,853	788,385,448	1.58
Freight mileage	114,566,173.191	97,842,569,150	1.70
Passengers carried ..	514,982,288	504,106,525	0.21
Passenger mileage ..	13,672,497,664	12,494,958,000	0.94
Earnings: Freight ..	$868,924,526	$780,351,939	1.13
Passenger	272,589,591	253,557,936	0.75
Miscellaneous ...	108,044,607	98,956,751	0.91
Total, gross ..	$1,249,558,724	$1,132,866,626	1.03
Net earnings	389,666,474	342,792,030	1.37
Earnings pr ton-mile	0.758 ct.	0.797 ct.	4.89*

*Decrease.

The share capital corresponding to the mileage completed at the end of 1898 equalled $5,581,522,858, against $5,602,964,449 in 1897, the decrease equalling $21,441,591, the rate of decrease being 0.38%. The funded debts of all the lines at the close of the year aggregated $5,635,363,594, against $5,534,432,492 in 1897, the increase equalling $100,931,102, being an increase of 1.82%. The other forms of indebtedness of the several companies at the close of the year equalled $368,182,584, against $380,669,705 for 1897, a decrease of $12,487,121. The total share capital and indebtedness, exclusive of current accounts of all the roads making returns, equalled at the close of the year $11,585,069,036, an increase in the year of $67,002,390 over the total of 1897 ($11,518,066,646), the rate of increase for the year being 0.58%. The cost per mile of all roads making returns, as measured by the amount of their stocks and bonded indebtedness, equalled $61,207, against $60,679 for 1897.

The total mileage of new railway constructed during the year 1898 was 3,199.12 miles, divided among the different groups of states as follows:

Group of States.	Constructed in 1898.	Total mileage on Dec. 31, 1898.
New England	126.00	7,380.72
Middle	173.94	22,034.43
Central Northern	365.25	40,429.74
South Atlantic	424.33	20,746.11
Gulf and Mississippi Valley	376.68	15,272.87
Southwestern	912.37	36,179.20
Northwestern	454.54	30,113,90
Pacific	366.01	14,652.72
United States	3,199,12	186,809.69

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SERIES ARC LIGHTING FROM CONSTANT CURRENT TRANSFORMERS.*

By Wm. Lispenard Robb, M. Am. Inst. E. E.†

Various methods of operating series arc lamps from alternating current systems have been suggested, and are in successful operation. In several well-known stations in this country, continuous current series arc dynamos are driven by synchronous or induction alternating current motors, the arc dynamos being either direct-connected to motors or belted from a line shaft which is driven by motors. In England, direct-current series arc lamps are operated successfully from rectifiers. In 1896 the Hartford Electric Light Co., with which I am associated, decided that it would be advantageous to make a radical change in its system of series arc lighting, with a view to obtaining a greater economy of operation. The series commercial arc lamps and the street lamps in the same section of the city were changed over from series open-air arc to constant potential arcs. It was considered advisable to continue the series arc lamps for lighting the outlying portions of the city. Propositions were considered both for using motor-driven series arc dynamos, and for using rectifiers. An order was finally placed with a manufacturer for a rectifier. A satisfactory rectifier never materialized, and we were unsuccessful in our attempts to import one from Europe.

The development of the enclosed arc lamp quickly led to the evolution of a satisfactory alternating current arc lamp of the constant potential variety. The perfection of this lamp led Mr. Richard Fleming, one of the engineers of the manufacturing company, to suggest the advisability of operating series alternating arc lamps from the constant current transformer, which formed one of the essential parts of the rectifier.

An experimental transformer having a capacity for operating 30 lights in series, was installed in April, 1898. After being subjected to a thorough test in the central station it was put in practical operation on a street circuit. The results of these tests were so satisfactory that an order was soon placed for several transformers each having a 100-light capacity. The first of these transformers was installed about a year ago and during the year all of the continuous current series arc dynamos have been replaced by constant-current transformers.

The Constant Current Transformer.

Each transformer is enclosed in a cylindrical tank. The tanks were originally made of boiler iron riveted up, but it proved impossible to keep these tight against the transil oil in which the transformer is immersed. The tanks are now made of cast iron.

The core of the transformer is of the shell type, with a large central vertical core rising the whole height of the tank. This central core is surrounded by the primary and secondary coils and the magnetic circuit is closed by return paths outside the coils. In the transformers, as made by the General Electric Co., there are two primary and two secondary coils. One of the primaries is fixed at the bottom, and the other at the top of the central core. The two secondaries are free to move up and down between the primary coils, and are so connected together that when one falls the other rises. They may approach into contact with each other at the middle of the tank, or from this position one may rise toward, the primary coil at the top while the other falls toward the primary coil at the bottom. Connected with the chains by which they are balanced is a lever which extends outwardly from the top of the oil tank and carries depending from its outer end a heavy adjustable weight. The lever is supported on a hardened steel knife-edge. This weight tends to force the two secondary coils respectively toward the two primary coils. When the transformer is in operation, the currents induced in the secondary react upon those in the primary and tend to force the coils apart. This force is balanced for the desired normal current by the adjustable weight outside of the case. If the resistance of the secondary circuit falls, due to the cutting out of lamps, the current increases slightly, increeasing the repulsion effect, and the secondary is pushed further away from the primary, giving a chance for increased magnetic leakage between the primary and the secondary, which reduces the E. M. F. in the secondary, bringing the current down to practically normal, even with wide changes of resistance. The regulation obtained is adjustable by means of a cam-shaped segment which can be moved on the outer end of the weighted lever. The principle of regulation was first suggested by Prof. Elihu Thomson, and its application to the operation of constant current transformers is broadly patented by him.

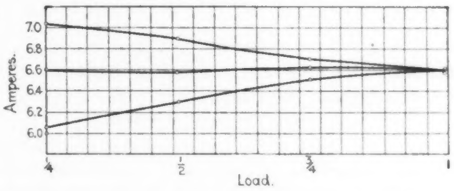

Fig. 1.—Regulation Test, Showing Constant Negative and Positive Regulation of Transformer.

By bringing out the proper connections from the secondaries the total number of lights may be operated as a single circuit or operated in any desired number of multicircuits in a manner similar to the well-known method employed on the Brush series dynamos of large capacity.

The larger sizes of this type of constant current transformers are always so arranged that the lights can be run on two circuits, or a single circuit, as may be desired. Owing to the high voltage of the enclosed arc lamp, the 100-light transformers usually operate two circuits connected upon the multi-circuit principle.

The transformer can be adjusted so as to give practically a constant current between one-third load and full load. As the properties of the transformer make it undesirable to run the transformer at less than one-third load, no attempt has been made to so construct the transformer that it would regulate under smaller loads. By adjusting the cam-shaped segment from which the counterbalancing weights are suspended, it is possible to regulate the transformer so that the current will increase or decrease as the number of lights is varied. The curves shown in Fig. 1 show the range of regulation that can be obtained by varying the adjustment of the cam supporting the regulating weights.

The early tests showed that when the transformers were adjusted to give a constant current through any desired range of load that the lamps would draw different lengths on the arcs depending on the number of lamps on the circuit. The voltage across the terminals of the individual lamps was approximately 10 volts higher at one-fourth load than at full load, although the current was the same in both cases. The results of a test of a 100-light transformer made to show this effect is shown in Fig. 2. It has been found, however, that by varying the adjustment of the transformer it is possible to adjust it so that the voltage across the terminals of the individual lamps remains practically constant at various loads. If so adjusted, however, the current from the transformer is no longer constant but increases as the load increases. The adjustment that maintains a constant voltage across the terminals of the individual lamps seems the preferable one in those cases where the load of the transformer varies through a wide range. It is, however, of little practical importance in the operation of a street lighting circuit, as in that case the transformers are seldom operated in actual practice at less than 90% of full load.

Tests were made of the efficiency, power factor and temperature rise of the transformers. The input and output of the transformers were measured with Weston wattmeters, ammeters and voltmeters, and were calibrated before and after test with standard laboratory instruments.

The averages of the results obtained from two 100-light transformers were as follows:

	Efficiency.	Power factor.
One-fourth load	88.1	24%
One-half load	92.3	44%
Three-fourths load	94.9	62%
Full load	96.1	78%

The rise in temperature of the oil of the transformer measured at the top of the iron core where it was highest was 39° C. after a 24-hours' run.

Under the usual conditions of street lighting, the dynamos are run under at least 90% of full load, and at this load the efficiency and power factor are very satisfactory. The power factor is about as high as that of the induction motor under the average load at which they are operated.

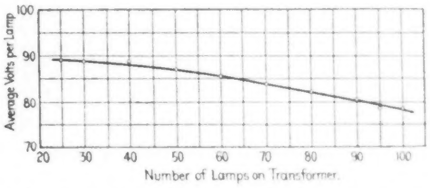

Fig. 2.—Curve Showing Variations in Volts per Lamp as the Number of Lamps on the Transformer is Changed.

The low power factor at fractional loads, and the difficulty in maintaining the lamps at constant voltage when the current is constant at various loads combine to make the constant current transformer undesirable except when the conditions are such that it is possible to operate the transformer under a large part of its rated full load.

Although the voltage at the terminals of the primary of the transformer is subject to a variation of 5% during the street lighting hours, the current supplied to the series lighting circuits is practically constant.

Before the changes in the street lighting system the lamps were operated from Excelsior, Thomson-Houston and Brush series dynamos, belted from the line shaft. This was driven by a direct-connected synchronous motor. The power furnished the synchronous motor was 550 watts for each open-air arc lamp consuming 315 watts at the lamp. The power required under the local Hartford conditions for operating street lights has therefore been reduced by the change in the ratio of 550 to 400, or a little over 27%.

Owing to the fact that the transformers are operated from outlying sub-stations, the wiring system has been very much simplified, and the cost of carrying current across the underground district considerably reduced. The maintenance of the transformers and the labor in looking after their operation is an almost negligible item. A very considerable saving is made over the maintenance and operation of the series direct-current dynamo. From experience extending now over a year it has become evident that the saving in operating expenses will pay for the entire cost of the change in system within the first two years.

In the discussion following the reading of the above paper, it was pointed out by Mr. C. P. Steinmetz that the constant current transformer was especially adapted for use on single-phase lighting circuits of 60 cycles, or over, while the rectifier found its field of usefulness in connection with polyphase power circuits operating at lower frequencies. It is difficult to operate a rectifier at moderately high frequencies, especially on single-phase current, while arc-lamps fed with an alternating current of low frequency have a disagreeable flickering.

* * *

BOOK REVIEWS.

TRAITE DE NOMOGRAPHIE.—Theorie des Abaques, Applications Practique, Par Maurice d'Ocagne, Ingénieur des Ponts et Chaussées, Professor a l'Ecole des Ponts et Chaussees, Répétiteur a l'Ecole Polytechnique. Paris: Gauthier-Villars. Paper; 6½ x 10, ins.; pp. 480; 172 cuts.

The word Nomographie will look strange to most of our readers, but they are all more or less familiar with the subject in actual practice. This branch of mathematics has for its object the reduction of the calculations which necessarily intervene in the practice of the different technical arts to simple readings from graphical tables, prepared once for all. By this means many otherwise difficult computations can be performed with all the precision usually required in engineering operations by

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*Slightly condensed from a paper presented before the American Institute of Electrical Engineers.

†Professor of Physics, Trinity College, Hartford, Conn.

the mere inspection of accurately drawn curves. Moreover, many calculations can be made in this way which are impossible by ordinary algebraic methods, or can only be reached by a long series of approximations. This method is not to be confused with the methods of graphical analysis, properly so called, which reach the desired results by direct construction, and which are so well adapted for use in the solution of problems of statics, although it can very profitably be used in connection with them. Many writers have used the methods of nomographie, or touched upon the subject before, but M. d'Orague has given us the first comprehensive treatise on this important, at least from the practical standpoint, branch of mathematics. The first and by far the greater part of the book is given over to the practical application of the methods developed, while in the second part, which is highly mathematical, the author investigates the general theory.

ANALYSES ELECTROLYTIQUES.—Par Ad. Minet, Ingénieur-Chemiste. Directeur du journal "l'Electro-Chimie;" Paris: Gauthier-Villars; Masson et Cie. 4½ × 7½ ins.; pp. 176; paper, uncut edges; 13 cuts; 4 tables; 2.50 francs.

This volume, which completes a series of books on electro-chemistry by M. Minet, attempts to give a clear conception of the principles upon which the methods of electrolytic analysis are based and could be read by chemists unfamiliar with this science. The scope of the book is best shown by the headings of the chapters, which we give below:

Chap. I. Historical. General considerations. The electrolytic method. Electrolytic constants.

Chap. II. Qualitative and quantitative analysis of metalloids.

Chap. III. Quantitative analysis of the individual metals.

Chap. IV. Separation and estimation of metals in compounds.

Chap. V. Separation and estimation of metals in alloys.

The methods of analysis based upon electrolytic phenomena, and more particularly upon the decomposition by the electric current of the metallic salts in solution, commend themselves by the simplicity of the required apparatus, the ease of their operation and the accuracy of the results. Moreover, they do not require special knowledge or skill on the part of the experimenter, nor excessive care in their operation, and are well adapted to replace many of the methods now in use. This book gives a very good account of the theory and practical application of electrolytic methods, together with the necessary data, and can be recommended to those interested in the subject.

THE RISE AND DEVELOPMENT OF THE LIQUEFACTION OF GASES.—By Willett L. Hardin, Ph. D., Harrison Senior Fellow in the University of Pennsylvania. New York: The Macmillan Co. Cloth; 12mo.; pp. 247; 12 illustrations. $1.50.

This brief work is of timely interest. So much error is now being published in the newspapers concerning liquid air that it is gratifying to find a book which avoids the realms of imagination and deals only with historical and scientific facts. The preface says:

> The object of this little volume is to present a complete history of the development of the methods employed in the liquefaction of gases. Sufficient theory has been given to enable the popular reader to understand the principles involved. While the book has been written in a popular science style, an effort has been made to make it of value to those who are especially interested in the subject by giving the references to the original literature.

The book begins with the early history of experiments on compression of gases, discusses the laws of Boyle, Charles and others, and then treats historically of the numerous attempts, many of them unsuccessful, to liquefy various gases, from Count Rumford in 1797 to Dewar and others a century later, concluding with Dewar's success in obtaining liquid hydrogen in 1898. The solidification of certain gases, such as carbonic acid, is also described. The first three-quarters of the book are taken up with the history and discussion of a number of attempts previous to 1895 to liquefy gases by means of a combination of high pressures and of low temperature produced by the evaporation of a volatile liquid. It is curious that the regenerative or self intensive method, which seems by far the simplest of all methods, and the only one now used for making liquid air, was not practically adopted for the purpose until 1895, although the regenerative principle for refrigerating air was patented by Siemens as early as 1857, and although E. J. Houston, in 1874, published a suggestion, which was almost a demonstration, that the principle of the Windhausen refrigerating machine might be utilized for the liquefaction of gases, and for scientific research in other lines, such as the determination of the absolute zero. Siemens, in 1857, in describing his refrigerating machine, said:

> The principle of the invention is adapted to produce an accumulated effect, or an indefinite reduction of temperature.

But it has taken forty years to bring this principle into practical use in the liquefaction of gases, while the great physicists of the world have been attempting to liquefy gases by more complex and difficult methods, remaining in ignorance, apparently, of the suggestions of Siemens and Houston.

The book is well written. It is as complete as need be on the history of the subject, but it might have been well to have devoted a little more space to a discussion of the present prospects, from an industrial and commercial point of view, of the manufacture and use of liquid air. A long quotation from Nernst is given to combat the idea of some inventors that the use of liquid air will enable us to transform the "low-grade heat of the universe" into mechanical energy. Dr. Hardin would have done better if he had presented in his own words a clearer demonstration of the absurdity of the idea.

We note that the author speaks of the law of Charles-Gay Lussac. In these days of hyphenated namea it might be supposed that this was the name of one person. The fact that he has in another place stated that the law is referred to as "the law of Charles, the law of Dalton, or the law of Gay Lussac," does not justify the use of the hyphen in place of the word "or," which would be understood by everybody.

We suggest to the publishers, and to all publishers of scientific books, that they should pay greater attention to the lettering of their cuts. Photographic reductions of engravings should not be made without re-lettering the original with letters of such a size that they may be easily found and read in the reduced cut. In some of the cuts in this book one or more letters have become invisible, and others are so small that they are difficult to find.

* * *

THE DESIGNING OF COLUMNS FOR FREIGHT AND PASSENGER SHEDS EXPOSED TO WIND.

By J. J. Pemoff.[*]

There is a class of structures, where the design of the columns will be governed by other considerations than the load which they have to support. To this class belong freight and passenger sheds on piers and bulkheads. The stress in the columns of such sheds produced by the vertical loads is relatively very small in comparison to that produced by the wind, and if the material in the column is sufficient to take up the wind-bending moments, very little additional section need be provided for the vertical loads.

The proper determination of the effect of the wind on the columns becomes very important in a design of this kind. Let Fig. 1 represent one bent of such a shed with the wind blowing from the left. Let the intensity of the wind transferred to each vertical foot of bent be p, and let the dimensions of the bent be as shown. The total horizontal pressure then equals p h. The roof truss is riveted to the columns in every case. The columns are either anchored to the pier with bolts and stirrups or only lagscrewed into the woodwork of the pier.

In the latter case, or in the case where the anchoring is not perfect, no bending moment can be developed at the base of the columns, and the only force there will be the reaction p h, equally distributed between the two posts. The maximum bending moment will then occur at the point B, and its amount is $M_b = p\,h\,c - \frac{p\,c^2}{2}$, if the structure is inclosed on the sides, or, $M_b' = p\,h'\,c$, if it is open.

This case is comparatively simple. When the columns are securely anchored, the direction of their neutral axis at the base may be considered constant during bending, and a bending moment, M, will be developed at the base, in addition to the reaction p h, which also has to be taken up at the base of the posts. The bending moment in the posts M_x at a distance x from the base will be

$$M_x = p\,h\,x - \frac{p\,x^2}{2} - M = E\,I\,\frac{d^2\,y}{d\,x^2}. \qquad (1)$$

where,

E = is the coefficient of elasticity;

I = the moment of inertia of the section of the post;

x = the vertical ordinate, and

y = the horizontal ordinate,

the origin being at the base.

Integrating (1) between the limits of x = o and x = c, we get

$$E\,I\,\frac{d\,y}{d\,x} = \tfrac{1}{2}\,p\,h\,c^2 - \tfrac{1}{6}\,p\,c^3 - M\,c. \qquad (2)$$

Equation (2) divided by E I will give the tangent of the angle which the element of the neutral curve at B will make with that at C. It can easily be seen and reasoned out, however, that the part A B does not bend, but only moves forward and parallel to its original position. In equation (2) $\frac{d\,y}{d\,x}$ then must be equal to O, and equation (2) gives after dividing by C and transposing,

$$M = \tfrac{1}{2}\,p\,h\,c - \tfrac{1}{6}\,p\,c^2. \qquad (3)$$

If the structure is open on the sides the term $\frac{p\,x^2}{2}$ in (1) disappears, and

$$M' = \tfrac{1}{2}\,p\,h'\,c. \qquad (3')$$

A little thought will show that after bending the bent tends to take the shape shown in Fig. 2, and that the bending moments at B and C are of opposie signs. Consequently, there must be a point of no bending, or of contraflexure between C and B.

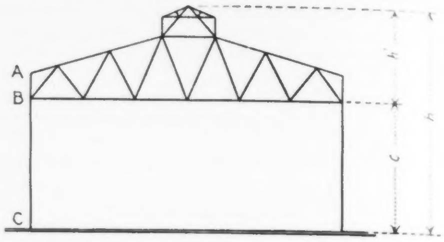


Fig. 1.

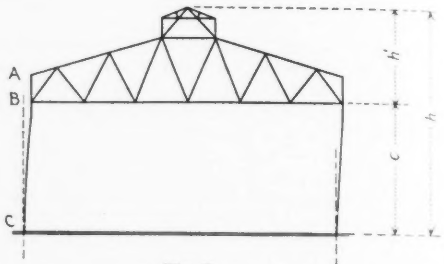


Fig. 2.

Let that point be at a distance X_c from the base. Substituting the value of M from (3) in (1), making (1) equal to O and solving for X_c, we get

$$X_c = h \pm \sqrt{h^2 - c\,h + \frac{c^2}{3}},$$

or

$$X_c = h \pm \sqrt{\left[h - \frac{c}{2}\right]^2 + \frac{c^2}{12}}.$$

As the point in question is between C and B, the first value of X_c must be rejected and

$$X_c = h - \sqrt{\left[h - \frac{c}{2}\right]^2 + \frac{c^2}{12}}. \qquad (4)$$

When $c = \tfrac{1}{2}\,h$ or $\tfrac{1}{3}\,h$

$$X_c = .48\,c.$$

For the case of an open structure by repeating the same operations, only using equation (3′) and omitting the term $\frac{p\,x^2}{2}$ in (1), we get

$$p\,h'\,x_c - \tfrac{1}{2}\,p\,h'\,c = O, \;\because\; x_c = \frac{c}{2}. \qquad (5)$$

The bending moment at B,

$$M_b = p\,(h - x_c)\,(c - x_c) - \frac{p\,(c - x_c)^2}{2}. \qquad (6)$$

for an enclosed structure, and

$$M'_b = \frac{p\,h'\,c}{2}. \qquad (5')$$

for an open structure.

When there is a knee brace inserted between the roof truss and the posts, C may be taken as the distance from the lower end of the knee brace to the base of the post.

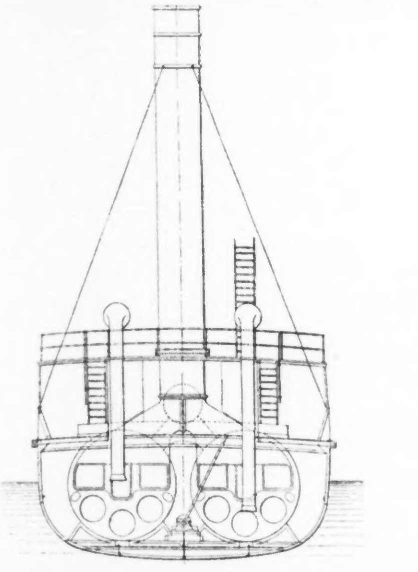
A practical example will show that the amount of metal saved in the posts by effectively anchoring them and by the use of knee braces is very considerable. The amount of anchorage required is given by the value of M and M′ in (3) and (3′). The stress on the anchorage bolts will be obtained by dividing into ½ M or ½ M′, as the case may be, the distance between the centers of the bolts in a direction parallel to the plane of the moment M.

[†] Engineers' Office, Department of Docks, New York city.

THE 1,000-HP. LADDER DREDGE FOR THE VLADIVOSTOCK HARBOR IMPROVEMENT WORK, RUSSIA.

(With full-page plate.)

The powerful ladder dredge illustrated in the accompanying cuts and on an inset sheet in this issue, was designed by the well-known dredge building firm of A. F. Smulders, of Rotterdam, Holland, for work on the harbor improvements now being carried on by the Russian Government at Vladivostock. As the proposed terminus of the Trans-Siberian railway, it was necessary that this harbor should have a sufficient depth to accommodate the largest ocean steamers, and this required a large amount of dredging, besides other improvements. Almost the first act of the Russion Government was, therefore, to order dredges for this work, and one of these orders was given to the well-known Dutch dredge builders named above. As described in a recent number of "Le Genie Civil," from which we reproduce the accompanying illustrations, the dredge is 49.5 m. (162.36 ft.) long, 10.1 m. (33.13 ft.) wide and 3.81 m. (12.5 ft.) deep.

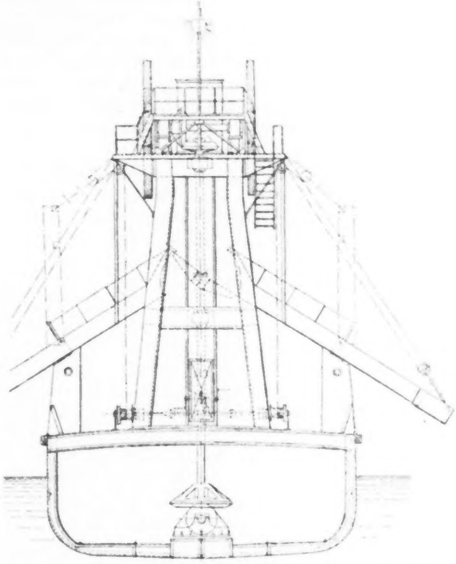


Transverse Section of Dredge for Vladivostock, Siberia, Harbor Work, Showing Arrangement of Boilers.

The hull of the dredge is of steel, as is also the framework of the bridge carrying the upper end of the ladder frame. As will be seen, the forward vertical supports for the bridge extend down to the bottom framing of the hull, while the stern supports extend only to the deck line. The ladder frame consists of two steel plate girders braced together by transverse struts. The sprocket at the upper end of the ladder frame for driving the bucket chain is quadrilateral, and that at the lower end is hexagonal. The buckets themseives have a capacity of 600 liters (21.2 cu. ft.) each, and are constructed of plate and cast steel, with cutting edges of hardened steel. These buckets are so designed that they may be taken apart and new parts inserted in the place of those that have become broken or worn out. The mechanism for operating the dredge is placed on a platform at the rear part of the bridge.

In the deckhouse are the two cabins for the captain and engineer, and ahead are other cabins and herths for the chief dredger, chief machinist, and their two assistants, and for the ten deck hands. Ahead of the deckhouse is located the machinery for raising and lowering the ladder frame, and hand and power windlasses and capstans, cranes, etc., for carrying on the various operations of the work. Finally the dredge is provided with twin screws capable of giving it a speed of 10 French miles per hour. Both the exterior and interior of the dredge are lighted by electricity generated by a dynamo operated by a small independent engine and vertical boiler.

The main engines are two vertical compound engines of 500 HP. each. Steam is furnished to them and to all other motors, except the dynamo engine, by two marine boilers having together 290 sq. m. (3,120 sq. ft.) of heating surface and carrying 105 lbs. pressure. The coal bins have a capacity of 50 French tons. The engines are surface-condensing, with cylinders 0.5 m. × 0.55 m. and 1 m. × 0.55 m.; the cylinders being equipped with drain cocks and indicators, and also with safety valves. They are lagged with felt and teak wood, held in place by brass hoops. Lubrication is accomplished by an oil pump. The pistons are cast steel. The low pressure cylinder has connections permitting the use of steam direct from the boiler in case of necessity. The air pumps are single-action, and the circulating pumps are double-action, and both are operated from the crosshead of the high pressure cylinder. The air pump has 0.25 × 0.3 m. pistons, and the circulating pump has 0.3 × 0.3 m. pistons. There are also two more pumps, 0.6 × 0.3 m., one being used to supply water for the boilers and the other for draining the hold. The condensers are of iron with plates and tubes of brass, and the total amount of cooling surface for each is 65 sq. m. (699.4 sq. ft.). As will be seen from the illustrations the main engines may be used to operate either the screws or the bucket chain as desired.



Transverse Section of Dredge for Vladivostock Harbor Work, Showing Arrangement of Discharge Spouts.

According to the tests made, the capacity of the dredge is about 350 cu. m. (457.8 cu. yds.) per hour in compact clay, with a mixture of stones, and about 500 cu. m. (654 cu. yds.) in less difficult material. The fuel consumption during the tests was 0.86 kg. (1.89 lbs.) of coal per indicated horsepower. As will also be seen from the drawings, the buckets can discharge on either side of the dredge.

A LIQUID AIR GOLD EXTRACTION COMPANY.

The following advertisement appeared in the New York "Sun" of Sept. 25:

> LIQUID AIR MINING COMPANY.
> Capital Stock, $5,000,000,
> Divided Into 500,000 Shares, Par Value $10 Each.
> Man Triumphs; Nature Yields.
>
> Westward the human hordes tramped to secure the yellow metal—gold—while tons piled upon tons of auriferous sands and ores are to be found in all parts of the world, only waiting until the brain of man could devise a way to extract the precious metal in paying quantities. THE LIQUID AIR MINING COMPANY can well exclaim, "Eureka!" When its processes and devices are applied to these sands and ores, the rich metals are produced even to the minutest particle. Did you know this? Do you want to know? Are you up to date? A seeker after knowledge? Then write for the Company's literature, or call.
>
> This Company offers 10,000 shares of its Treasury Stock, at $2.50 per share, for a limited time only. Address
>
> B. H. PEARSON, Treasurer,
> St. Paul Building,
> 220 Broadway, New York.

As the office of Mr. Pearson is in the same building as the office of Engineering News, and as seeking after knowledge is directly in our line, it seemed advisable for a member of our staff to call upon him. After some search he was located in a small room on the 10th floor. "How is liquid air being applied to mining?" was asked. "Oh, we only use it as an explosive," he replied, and he then proceeded to explain that it was mixed with alcohol, put in a cartridge, and exploded. Experiments had been made with it, he said, somewhere in New Jersey, and it had proven wondrously effective.

"What has this explosive cartridge to do with extracting gold from auriferous sands," was asked, and for reply we were referred to a man sitting at an adjoining desk, who was called "Judge Laird." To him we are indebted for a very full explanation of the "gold extracting" process. It appears that the company has learned that there are untold millions of tons of gold-bearing sands in the Adirondack region, in New York State, which can be mined with a shovel—no explosives needed—in some portions of which the gold runs at $5 to $6 per ton. This gold, however, so Judge Laird says, does not exist as free gold, but is so combined with magnetic and "dimagnetic" oxide of iron, that chemists generally have failed to find it by the ordinary fire assay. By the Liquid Air Mining Co.'s process, however, it is found, and by it may be extracted. The Judge exhibited drawings of a modification of the ordinary Chilian grinding mill, in which the rolls are made of the shape of a truncated cone, and have an axial motion in addition to the rolling motion common in such mills. The shape of the rolls and the axial motion is said to cause the rolls to rub the sand which is being crushed, in addition to crushing it by rolling in the ordinary way, and thus to pulverize the sand more completely. To the sand while being pulverized there is added a small amount of a liquid, which was described as being "mercury in liquid form," the use of which is to begin the process of amalgamation. This "solution" of mercury is claimed to get at the fine particles of gold, which, according to the "Judge," does not exist as free gold, but in combination with iron oxide, and which metallic mercury cannot reach. The crushed sand, with the partially amalgamated gold, is floated out of the mill by water into a series of amalgamating pans, in which metallic mercury is placed in the usual way, and the amalgamation is therein completed, the gold being extracted from the amalgam afterwards by retorting in the ordinary way.

"What has liquid air to do with this extraction process?" was asked. "Oh, nothing at all," was the reply. "Liquid air is only the name of the company. Some of our directors are interested in liquid air, and they thought it was an attractive name, on account of the general public interest in liquid air."

"Have you any reports of chemists or of mining engineers on your process?" was asked. "We court the most thorough examination," he answered. "We have a plant in operation in Brooklyn, and any expert may send his gold-bearing sand there and we will treat it for him."

A visit was next paid to this plant, which was found in a cellar under No. 434 Kent Ave., Brooklyn. There was the modified Chilian mill, with an overflow trough leading to a series of three rotary amalgamating pans, two iron retorts of about a pint capacity each, a blacksmith's forge, in which the retorts might be heated, a beer bottle full of the mysterious mercury solution, the composition of which is the company's "secret," perhaps half-a-ton of sand, said to be gold-bearing, a few bags, said to contain gold ores from different places, and about a bushel of mud on the floor, representing the tailings of a recent operation. The plant was in charge of a Mr. Smith, who exhibited the action of the liquid in the beer bottle. This instantly whitened the surface of a copper strip, which was afterwards easily amalgamated on being plunged in metallic mercury. The liquid acted exactly as a solution of mercury in acid would have done, such a solution as is sometimes sold by peddlers as a "silver-plating solution." He repeated the statements of Judge Laird as to the willingness of the company to have its process investigated. All that it asks is to have any expert send a car load of gold-bearing sand, and it will be treated by the process. We noticed, however, one difference between Mr. Smith's statements and Judge Laird's. The former said that the Adirondack sands contained free gold, while the latter said it was not free, but combined with iron oxide.

At a later date another member of our staff visited Mr. Pearson's office, and received some further information from that gentleman. He was told this time that the company had patent applications pending on "the use of liquid air for mining." Names of the inventors were asked for but refused. The company has just bought, according to Mr. Pearson, 80 acres of land covered with gold-bearing sands, in Essex county, New York; but he professed ignorance as to whereabouts in Essex county it was located. The Chilian mill drawing was exhibited, and it was stated this time that the mill was owned by "the Standard Process Co.," which also owned the secret of the mercury solution, the "Liquid Air Mining Co." possessing merely the right to purchase and use the mill and process in a certain territory. The information was also obtained that the secret compound was "a sodium hydrate of mercury," and enough of it to treat a ton of the gold-bearing sand cost just 60 cents.

Quotations are introduced in the company's prospectus from the "report of Prof. Chase, formerly of Cornell University," and "from a geological report"; but Mr. Pearson was ignorant as to whom Prof. Chase's report was rendered, and he was equally in the dark as to what the geological report was from which the quotation was taken.

Unless the concern can make some more plausible showing than was made in their exhibit to us, we fear the only suckers they will be able to land will be the kind that jump out of the water to swallow a bare hook.

REPORT OF THE COMMISSION ON THE IMPROVEMENT OF THE PHILADELPHIA WATER SUPPLY.

The long agitation for a better water supply for the city of Philadelphia, Pa., has been fully discussed in previous issues of Engineering News. As our readers will recall, it finally resulted, last April, in the appointment by the Mayor, Hon. Samuel H. Ashbridge, of a commission of expert engineers to investigate the whole question and report upon a plan for the immediate improvement and extension of the water supply of the city. The commission appointed by Mayor Ashbridge consisted of Messrs. Rudolph Hering, Joseph M. Wilson and Samuel M. Gray, all members of the American Society of Civil Engineers. They were instructed to act in conjunction with Mr. Wm. C. Haddock, Director of the Department of Public Works, Mr. John C. Trautwine, Jr., Chief of the Bureau of Water, and Mr. Geo. S. Webster, Chief of the Bureau of Surveys, of the city of Philadelphia, and to submit a preliminary report in 60 days and a final report in 90 days. The final report of the Commission was submitted in full on Sept. 21, and, summarized in a few words, it recommends the continued use of the water from the Delaware and Schuylkill rivers, and its purification by slow sand filtration. Considering the short time available in which to conduct the necessary investigations, the report is a comprehensive one, and goes far to settle definitely the problem of securing pure water for Philadelphia.

The report begins with a review of present conditions. The present population of the city of Philadelphia is 1,300,000 which must be provided with water at once. In making estimates for the future supply it was decided to assume a population of 3,000,000 in 1950. At present about 95% of the city's water supply is taken from the Schuylkill River, and about 5% from the Delaware River. All of the water is now pumped to artificial reservoirs located on elevated sites from which it is distributed through cast-iron pipes. Certain elevated suburban districts are supplied by high service pumping stations drawing from the reservoirs.

Comparing the Delaware and Schuylkill rivers in respect to the quantity and contamination of their waters, the report shows that the pollution of the Delaware is slight compared with the Schuylkill. The latter stream, besides the organic impurities, contains a great amount of sediment, and is at times highly impregnated with sulphates and carbonates of lime and magnesia. The greatest amount of suspended matter which has been reported is 1,026 parts per million, which indicates that at times a filtration of the Schuylkill water must necessarily be preceded by sedimentation to remove most of the suspended matter, and that at periods of great turbidity even a coagulant would be of great service and economy for the purpose of more rapid and thorough precipitation. At low stages of the Schuylkill River, 80 parts of alkaline sulphates per million have been found in the water. In regard to organic pollution the report states that an investigation of the Schuylkill River reveals contaminations of the most abominable kind. The principal source of pollution of the Delaware is the city of Philadelphia itself, although it receives the sewage from a number of towns above that city, including those located on its tributary streams, and particularly the Lehigh River, which takes the drainage of Bethlehem, Allentown and the tributary iron manufacturing districts. Below the Lehigh the river receives the sewage of Easton, Pa., and Trenton, N. J. Owing to the large volume of flow the dilution of the impurities is much greater than is the case with the Schuylkill water.

The capacity and equipment of the present plant of the city's water-works is referred to in some detail. The plant is referred to as one of the largest in the world, and comprises: (1) Thirty-seven pumping engines, with a rated total pumping capacity of 399,090,000 gallons daily. Of these pumps 30 are operated by steam and seven by water power; (2) eleven reservoirs, two standpipes, and three tanks with a combined capacity of 1,417,860,000 gallons; (3) a system of more than 1,250 miles of water mains varying in diameter from 4 ins. to 48 ins., together with the necessary valves, fire hydrants, etc.; (4) the Fairmount and Flat Rock dams. The pumps vary in capacity from 250,000 gallons to 30,000,000 gallons each per 24 hours, and are contained in ten pumping stations, five of which take water directly from the Schuylkill River and one from the Delaware River, the other four being high-service stations. It is pointed out that repairs are needed in various portions of this plant to put it in good condition. This does not include repairs or renewals to the distribution system, but it is pointed out that there is hardly a district in the city in which some portion is not suffering from want of water owing to incrustation and other troubles.

Several very interesting facts and comparisons are pointed out in respect to water consumption and water waste in Philadelphia. Referring to the figures of water consumption per capita, published in the recent annual reports of the Bureau of Water, the Commission's report states that "it is evident that the figures do not represent the actual use per capita per day, but that there is added an unnecessary waste." The diagram, Fig. 1, shows the quantity of water consumed in various cities between 1860 and 1898 per capita per day, as compared with that consumed in Philadelphia. This last city is represented on the diagram by a heavy line. Buffalo, N. Y., and Washington, D. C., are the only cities exceeding Philadelphia in the per capita rate. The report considers that 150 gallons per capita per day, or 200,000,000 gallons per day, should be a liberal allowance for the actual requirements of the present population of 1,300,000. Concerning this question of consumption and waste, the report speaks further as follows:

> No restriction should be placed upon the use of water required for health, comfort and cleanliness; nor should a part of the community be encouraged to deprive another part of its full quota of water. We are, therefore, emphatically of the opinion, and strongly urge, that all practicable means should be adopted to secure a fair and equitable distribution of the city's water. We know of no better means to this desirable end than the introduction of water meters, not only for all business properties and manufacturing establishments, but also for such private consumers as are found, by the Department of Public Works, to be carelessly wasting water from the public supply. This remedy is available and simple, and it has been already adopted in many cities with entire satisfaction.
>
> Fig. 2 shows graphically the decrease in consumption per tap in a number of cities where meters have been introduced. In 1880, the City of Milwaukee, Wis., had only 26 meters and the daily water consumption per tap was 1,781 gallons. In 1898 it had 22,096 meters, with a daily consumption per tap reduced to 644 gallons. About 70% of all private buildings, all railway stations, all business properties and manufacturing establishments were metered There remain only 30% of consumers whose supplies are not metered, and yet the amount generally taken through this 30% for domestic purposes, equals in amount the whole quantity of water delivered by the meters to the remaining 70%. Notwithstanding the extravagant waste through unmetered connections, the total consumption per capita per day was reduced from 220 to 80 gallons. Many other cities show similar results. The diagrams show several of them.

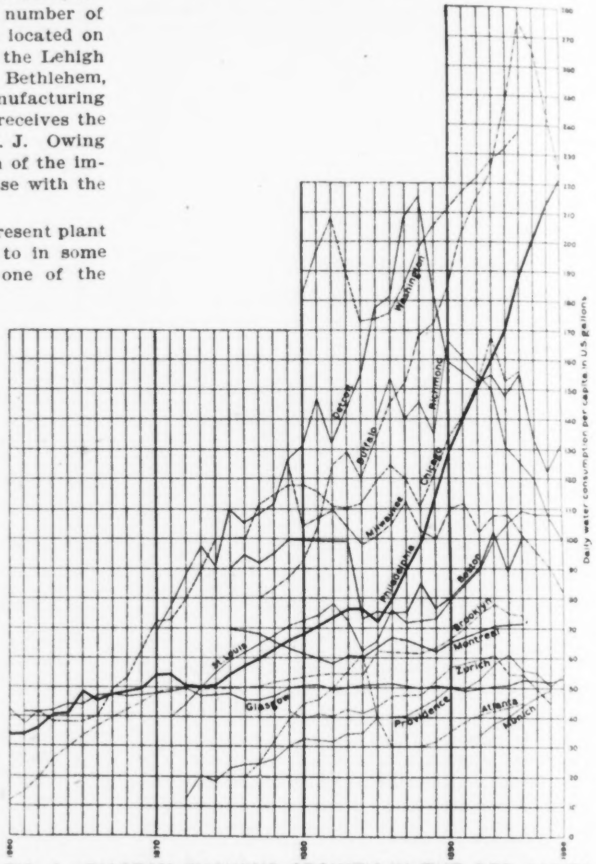
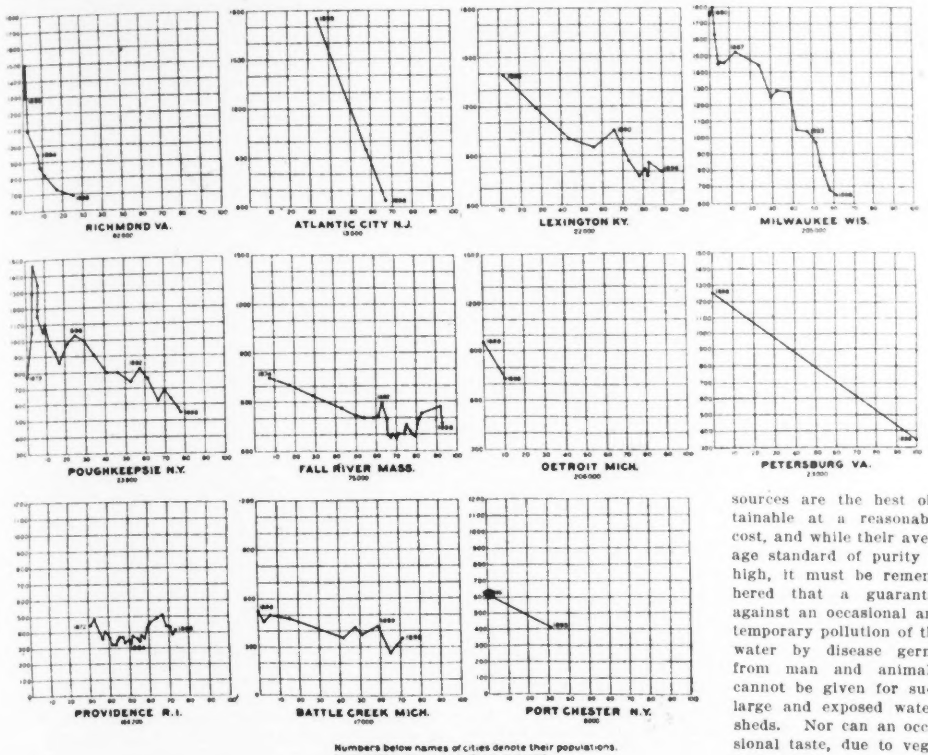


FIG. 1.—DIAGRAM SHOWING GROWTH IN THE PER CAPITA CONSUMPTION OF WATER IN VARIOUS CITIES, COMPARED WITH THAT OF THE CITY OF PHILADELPHIA, PA.

> The city of New York, which certainly requires as much water as Philadelphia, consumed in 1898 for the Boroughs of Manhattan and Bronx, 121 gallons per capita per day for a population of about 2,000,000 inhabitants. It had in use over 35,000 meters in these two boroughs, covering, it it said, every place where water was used extensively for other than domestic purposes.
>
> The report of the Commissioners for the city of Pittsburg advises very strongly the introduction of meters in connection with their new supply.
>
> The consumption per tap for Detroit, as given by Fig. 1, commenced to decrease after meters came into use, and in 1898 it was only 730 gallons per day as against nearly 950 gallons in 1888. In 1888 the Sunday waste is said to have been from 50 to 60 gallons per capita, and the average waste for the entire year was thought to have been from 30 to 45 gallons per capita per day. A system of inspection was established and this appears to have been very effective. A careful record was kept of the condition of the plant, but the per capita waste was still about 6 gallons daily. It is stated that at present practically all manufacturing, business, municipal, public and semi-public consumers, and about 4,000 private families have meters.
>
> We earnestly recommend the introduction of meters for the city of Philadelphia, with perfect confidence that the private consumer is given full and ample use and enjoyment of all water for his needs and comfort, at no greater cost, and probably, in many cases, even less cost than the present rates impose. The meter is not proposed to increase the revenue, but to prevent one citizen from depriving another of his rightful share of water. A private corporation would introduce meters at an early day if not restricted by law, and would at the same time encourage consumption in every way.
>
> The lack of a sufficient supply of water in various parts of the city is due either to a deficiency of distributing pipes, to the lack of pressure from the reservoir, to the want of pumping machinery, to a waste of water, which reduces the head, or to two or more of these causes combined. The remedies are apparent.

Referring to the present reservoir system of the city, the report points out that as far as the limited investigations made show, it is in a fairly good condition. Storage reservoirs for compensating the yearly flow of the streams would be



Numbers below names of cities denote their populations.
Horizontal scale: per cent of taps metered.
Vertical " : daily consumption per tap.

FIG. 2.—DIAGRAM SHOWING THE EFFECT OF THE USE OF METERS ON THE CONSUMPTION OF WATER IN ELEVEN DIFFERENT AMERICAN CITIES.

required only in the event of the improved supply being taken from the comparatively small streams in the mountainous districts. If the Delaware and Schuylkill rivers are to be used at points near the city, the former at least, owing to its large size, constitutes its own storage reservoir, and, therefore, no special structures are needed for the specific purpose of equalizing the seasonal flow. Sedimentation reservoirs are not required if clear mountain waters are used, but if a filtered supply is secured from the Delaware and Schuylkill rivers, sedimentation reservoirs are required to give the water a preliminary clearing. The only use for clear water reservoirs in Philadelphia is for the purpose of providing for the irregular daily consumption, for accidents to the mains, fires, etc.

Regarding the quality of the improved water supply, it is premised that it should be up to the best recognized standards of purity in all respects. The water supplied to the city at present is scarce in quantity and inferior in quality. It is not only turbid in storms, but also subject to great sewage pollution. The deficiency of supply as to quantity can be remedied by diminishing the waste, or by increasing the pumpage. The defects in quality can be remedied either by abandoning the present sources of supply and adopting purer ones, or by applying to the water taken from the present sources well-known methods of purification. The first project requires the bringing of Blue Mountain water to the city, and the second requires a thorough filtration of the Schuylkill and Delaware river waters taken within the city limits. The quantities of water available from these sources by different plans are as follows:

	Gallons per day.
Mountain water (unfiltered): Lehigh River, including Big and Aquanchicola Creeks	360,000,000
Upper Perkiomen	90,000,000
Sources near Delaware Water Gap	260,000,000
Water requiring filtering: Schuylkill River at Philadelphia	150,000,000
Delaware River at Philadelphia	Unlimited.
Delaware River at Water Gap	350,000,000
Tohickon & Neshaming C'ks, with storage	144,000,000
Perkiomen Creek above Schwenksville, with storage	160,000,000

The estimated costs of these different plans are given in Table I.

The report enters into a somewhat extended consideration of the relative advantages of the several projects and discusses briefly the character of slow sand filtration and the experience and experiments with both slow sand filtration and mechanical filtration in the United States and abroad. The following is a summary of the conclusions reached:

It was considered that the water collected from the affluents of the Delaware and Lehigh rivers in the Blue Mountains, and from the Upper Perkiomen Creek, could be used in their natural condition. While these natural sources are the best obtainable at a reasonable cost, and while their average standard of purity is high, it must be remembered that a guarantee against an occasional and temporary pollution of the water by disease germs from man and animals, cannot be given for such large and exposed watersheds. Nor can an occasional taste, due to vegetable matter, be entirely avoided.

The alternative source of supply is the water of the Schuylkill and Delaware rivers, within or near the city limits, artificially purified to the required standard. The purification is obtained by filtering the water through sand; no better and cheaper method is known.

The progress made in this country and in Europe in ascertaining the laws of the mechanical and biological process of filtration, and the practical success obtained in filtering water for many years in large cities of Europe, confirm and warrant the conclusion that this method of purification can furnish this city, from both rivers, with water that will be clear and palatable, and will conform to the best bacterial and chemical standards.

When the raw river water carries much suspended matter with it, this must be allowed to subside, as a preliminary to filtration, so as to lengthen as much as practicable the time between the filter cleanings. Settling reservoirs are therefore essential as preliminaries to the filtration of the water of these two rivers. In order to secure the greatest practicable efficiency, the filter plant must not only be built with skill, and be provided with the best means for regulating the flow, and for cleaning the sand, but it must also be carefully operated by trained men, in accordance with the daily condition of the river water and of the filters.

Two methods of filtration are in common use: one allows the water to percolate slowly through a bed of sand, while the other allows it to pass through much more rapidly, and, in order to give it the same degree of purity, requires the use of a coagulating substance to prevent objectionable organisms and suspended matter from passing through the filter. The first we have called a slow, and the second, a rapid filtration.

Inasmuch as it has been impossible, in the time at our disposal, to make the necessary experiments showing the precise effects of filtering both the Schuylkill and Delaware waters, either through slow or rapid filters, it is also impossible now to state which of the two systems would be the more economical. But we know, and can positively assert, from experience obtained elsewhere, that, for the plants which we have recommended, a slow filter system will not materially differ in annual expense from a rapid filter system. We likewise know that the slow filters, from long experience, and from their successful operation in many cities, can, without question, yield satisfactory results with the waters of tho aboxe-mentioned rivers. The rapid filters have only recently been sufficiently developed to command a high degree of confidence in their results under all circumstances.

The actual plant proposed for the city is described in a general way as follows:

The slow filters are all designed for an average rate of 3,000,000 gallons of water per acre of effective area (about 9 cu. ft. per sq. ft.) per day. The number of filter beds eercted at each site at first would be only for present demands, and each plant could be increased thereafter from time to time, as found necessary, by additional filter beds, ample ground having been reserved for this purpose, except in the case of the Queen Lane. The area available for slow filters at Queen Lane is limited, so that provision cannot be made at that site to filter more than 58,000,000 gallons per day, although the amount used in that district will hereafter be considerably greater. This deficiency will be made up from East Park, and for that purpose high-service pumps at East Park will be required. A rapid filter plant has been adopted at East Park.

In considering the Schuylkill and Delaware rivers as sources of supply to be filtered for the city, we have decided upon the following main points:

(1) To utilize and adopt tho present plants as far as possible and to the best advantage.

(2) To use the Schuylkill water for the districts of Belmont, Roxborough and Queen Lane, with such surplus as may remain of the limited 150,000,000 gallons supply per day, for East Park.

(3) To abandon the reservoir at Fairmount, which is now in use only for about seven months in the year, and to connect the turbino pumps with Spring Garden station, so that they may be placed in service whenever the supply of water will allow, thereby relieving the steam plant of a corresponding amount of work.

(4) To abandon the Corinthian reservoir.

(5) To retain the Fairhill reservoir, which, although not now designated for use, will hereafter undoubtedly be found valuable as a center of distribution for filtered water and can be so adapted by modification and covering.

TABLE I.—Showing Estimated Cost and Cost of Operation of the Several Possible Alternate Projects for Improving and Extending the Philadelphia, Pa., Water Supply.

Mountain Water Snpply.*

		Cost,				
Source.	Daily supply, gallons.	Aqueducts, storage, etc.	Distribution to city reservoirs.	Total.	Annual; operation and maintenance.	Per thousand gallons.
Upper Perkiomen Creek and Lehigh River:						
Tributaries	200,000,000	$32,090,000	$1,320,000	$33,410,000	$1,205,000	1.65 cts.
With tributaries	450,000,000	64,590,000	2,150,000	66,740,000	2,480,000	1.51 "
Delaware River tributaries, near Water Gap, Upper Perkiomen Creek and Lehigh River tributaries	450,000,000	78,630,000	4,555,000	83,185,000	2,925,000	1.78 "

Slow Filter Supply.

Source.	Daily supply, gallons.	Filters and accessory works.	Mains bet. Torresdale plant—East Park Dist. system.	Total.	Annual; operation and maintenance.	Per thousand gallons.
150,000,000 galls. daily from Schuylkill River; 50,000,000 galls. daily from Delaware River	200,000,000	$9,453,591	$1,520,000	$10,973,591	$1,227,373	1.68 cts.
300,000,000 galls. daily Delaware River	450,000,000	23,174,691	10,980,000	34,154,679	2,971,801	1.81 "

Rapid Filter Supply.

Source.	Daily supply, gallons.	Filters, aquedcts & accessory works.	Distribution to city reservoirs.	Total.	Annual; operation and maintenance.	Per thousand gallons.
450,000,000 galls. daily from Delaware River, filtered at Portland	450,000,000	$62,542,747	$5,320,000	$67,862,747	$3,239,379	1.97 cts.
260,000,000 galls. daily, mountain water, from storage above Water Gap and 190,000,000 galls. daily from Delaware, filtered at Portland	450,000,000	73,325,052	5,320,000	78,645,052	3,170,805	1.93 "
450,000,000 galls. daily from the Delaware, filtered at Torresdale	450,000,000	15,798,376	6,120,000	21,918,376	3,108,606	1,89 "

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*The cost of delivering 700,000,000 gallons daily of mountain water into the city reservoirs would be $116,585,000, and the annual expense of operation and maintenance would be $4,310,000.

(6) To adopt slow filtration for Belmont, Roxborough, and Queen Lane districts, and rapid filtration for such remaining portion of the Schuylkill water as is delivered at East Park.

(7) To establish a slow-filter plant on the Delaware River below Torresdale, from which all the water not supplied from the Schuylkill will be obtained.

(8) To make use of the present reservoirs, whenever possible, for sedimentation and for the storage of filtered water.

(9) To allow at least 24 hours for sedimentation, and to provide storage capacity for one-half day's supply of filtered water.

(10) To cover all storage reservoirs for filtered water.

(11) To cover all filters.

It is, of course, eminently desirable that the water supplies for filtration should be as free from impurities as possible, so as to reduce to a minimum the duty on the filters; and every effort should be made, by legislation and otherwise, to prevent the pollution of streams; yet such water as exists to-day in the Schuylkill and Delaware rivers at the city of Philadelphia, can be purified by filtration and rendered wholesome and fit for all domestic purposes.

Within the city limits it is possible to locate the filter plants, at places where the water supplied them will not be subject to direct sewage pollution. A point can be selected on the Delaware River within the city limits, but above such direct contamination, and the present intakes on the Schuylkill are well situated in this respect. The locations and conditions of existing pumping stations and reservoirs are such that it is advisable to continue the use of the water in this river up to a quantity equal to its minimum flow, at least so long as the present plant can be made serviceable. For additional supply, and for future extensions, the Delaware is the proper source, and in time it is not impossible that the whole supply may come from that river.

In order to ascertain the suitability of certain sands, obtainable in the vicinity of Philadelphia, for use in filter plants, we have had mechanical analyses made of a number of samples. The results indicated that there will be no difficulty in obtaining suitable material for the purpose.

If the annual rates remain the same, the surplus earnings of the Bureau of Water would, to all appearances, be sufficient to pay for the continual extension of the plant as required by the growth of the city.

Owing to the improvements constantly being made in the operation of filtration plants, it is probable that our estimated cost of filtration will be found, in the future, to have been too high, rather than too low. It will be noticed that the estimated cost of filtering on the Delaware is slightly less than on the Schuylkill.

When the present reservoirs are converted into settling reservoirs for use prior to the filtration of the water, it will be necessary, in some instances, to re-adjust the water intakes and outlets, so as to accomplish the highest possible degree of sedimentation during the time that the water is passing through the reservoir.

It is advisable that filters and clear-water reservoirs be covered or roofed, to prevent the formation of ice on the surface, and to protect the filtered water from pollution by the dust in the air which carries the seeds of lower life. There is abundant evidence of the deterioration of filtered water, or of spring water, kept in open reservoirs. In covered reservoirs, the water is also cooler in summer, than when exposed to sunlight. There is an erroneous idea that sunlight and air are advantageous to stored water. The contrary has been frequently demonstrated, and everyone appreciates the excellence of spring water, which issues, so to speak, from the bottom of a large natural filter, without having been exposed to either sunlight or air. There are both chemical and biological reasons for these facts.

The slow-filter plants contemplated in our recommendations are similar, in general arrangement, to those of London and of Hamburg, and to the recently completed filter plant at Albany, N. Y. The latter is the largest filtration plant in this country.

We have said that we consider it inadvisable during dry years to obtain a greater amount of water from the Schuylkill River than 150,000,000 gallons per day. A provision for supplying the city with 200,000,000 gallons daily, therefore, requires 50,000,000 gallons a day to be obtained from the Delaware River; and all future increase of supply is assumed to be taken from this river. We have selected the neighborhood of Torresdale as the site for the new pumping station on the river because the present site at Lardner's Point will, in our opinion, not be suitable in the future, on account of the several large sewers now delivering, or which will soon deliver, a large amount of sewage into the river in that neighborhood.

Referring to the estimated costs of the different projects given in Table I., the report points out that: (1) The original cost of any of the mountain water supplies is very great for the large quantities of water which the city requires. (2) A filtered supply can be obtained at a first cost which is within the present borrowing capacity of the city, and the plant can be operated at a cost which will not exceed the probable annual net earnings of the water-works. In conclusion the Commission recommends: (1) The adoption of that project by which the waters of the Schuylkill and Delaware rivers, taken within the city limits, are purified by filtration. (2) The immediate improvement of the existing plant, in accordance with the detailed recommendations of the report.

ANNUAL CONVENTION OF THE EASTERN MAINTENANCE OF WAY ASSOCIATION.

The seventeenth annual convention of this Association (formerly the New England Roadmasters' Association), was held at Portland, Me., Sept. 26 to 29, the headquarters being at the New Falmouth Hotel.

At the opening session on Sept. 26 (at 2 p. m.), the President, Mr. J. M. Torr (N. Y., N. H. & H. R. R.), made a very brief address. The Secretary and Treasurer, Mr. F. C. Stowell (Boston & Maine R. R.), then read his report, showing receipts of $916, and a balance of $237. There are now about 90 members. The election of officers was then proceeded with and resulted as follows: President, E. A. Haskell (Boston & Albany R. R.); Vice President, F. E. Sibley (N. Y., N. H. & H. R. R.); Secretary and Treasurer, F. C. Stowell (Bos. & Me. R. R.); Executive Committee, John Patch (Bos. & Me. R. R.); M. C. Hamilton (N. Y., N. H. & H. R. R.), W. E. Tuttle (N. Y., N. H. & H. R. R.), and C. H. Pemberton (Bos. & Me. R. R.).

The Secretary then read three of the reports, all of which were very brief, and abstracts of these are given below, with particulars of the discussions.

The technical business was then resumed, and the report of the first committee was read, which was substantially as follows:

Maintenance of Right of Way in Neat Condition.

Uniformity of practice is a desirable feature and a potent factor in the accomplishment of a good general appearance of the line. Standards should be adopted by the management of the various details of construction, fixtures and designs, including cross section of roadbed, distance of sod line from rail, shape and color of all roadway signs, and their distance from the rail, the style of fencing, etc.

Employees of the transportation and motive power departments should be governed by rules tending to impress upon them the necessity of doing their part towards keeping the roadbed clean and thereby keeping the trackmen from doing work made necessary by the carelessness of employees of other departments. This would include the disposition of station and train rubbish, locomotive ashes, etc.

All track foremen should be encouraged to take pride in the condition and appearance of the roadbed, and should understand that a neat and tidy appearance will be substantially appreciated.

R. A. McQuaid, Geo. A. De Moore, G. L. R. French.

Mr. R. P. Collins (N. Y., N. H. & H. R. R.) thought that foremen should work to a definite system and routine. In this way they will not waste time by doing the same thing over and over again, and the work will be more economically done. Mr. Curtis said the foremen should be properly instructed as to methods of economizing time. Mr. Patch (Boston & Maine R. R.), said that when his road first began to require a neat and tidy condition of the road, the foremen complained that they had no time for this, but they soon found time when they found that their instructions were meant to be carried out.

The next report was that of the committee on "The Most Efficient, Durable and Economical Form for Standard Snow Fence, and the Best Form of Right of Way Fence." The following is an abstract of this report:

Snow and Right of Way Fences.

Where the right of way is sufficiently wide, a close board of fence should be used of height suitable for the snowfall of the locality. Where the right of way is narrow and there are many shallow cuts, a portable fence may be used, made in lengths of about 12 ft. These should be set up about 100 ft. from the track. When the snow has accumulated to the top of the fence the fence may be placed on top of the drift.

For the right of way, a woven wire fence is recommended instead of barbed wire, the details of size of wire, etc., being left to the manufacturer. A. C. Stickney.

Mr. Stickney (Boston & Maine R. R.) said that no wire fence would keep off trespassers near large cities, but we judge that he has not seen the high wire fence used by the Chicago & Northwestern Ry. In some cuts he uses snow fences built on the slopes, at an angle of about 45° with the track, and 60 to 90 ft. apart, alternating on opposite sides of the cut. This prevents the cut from filling with snow. For fence posts, he prefers red cedar first and chestnut next. Mr. Patch said he had used some woven wire and did not like it, but will try a nine-wire fencing of rectangular mesh. Across swamps, he uses barbed wire fencing on account of its cheapness.

At the evening session, the report of the committee on stone ballast and gravel ballast sprinkled with oil was first presented.

Comparative Merits of Stone Ballast and Gravel Ballast Sprinkled with Oil.

Trap rock broken to a 2-in. size is extensively used and gives general satisfaction. It should be at least 12 ins. deep under the tie, to prevent frost from having a bad effect upon the track. It maintains a good surface, is free from dust, and is not materially affected by rain.

The sprinkling of gravel with oil is very effective in preventing dust, especially in New England, where most roads have gravel ballast, which is very dusty. The oil also prevents the growing of weeds and grass, and increases the life of the tie from one to two years. Gravel ballast sprinkled with oil has all the essential qualities of stone ballast, and it is possible to make and maintain a more even surface with such gravel than with stone, with the same amount of labor.

Some members thought that an equally good surface could be kept with stone ballast as with gravel ballast, but when their attention was called to the fact that the report said at the same cost, they were not prepared to continue their claim. After some desultory discussion, it was resolved to hold the matter open for another year, in order to enable more complete information and records to be obtained as to methods, cost, durability, etc., more particularly in regard to the oil treatment.

The next report was that of the committee on the preservative treatment of cross ties. It was not an important addition to the literature on the subject, and received little discussion.

The Advisability of Chemical Treatment for Ties for Railways in New England.

Experience has clearly shown that decay can be prevented for many years by chemical treatment, but only three distinctive processes have stood the test of time and proved their commercial value: (1) kyanising, the cost and danger of which put it out of the question; (2) creosoting, which is efficient, but costly, and (3) burnettising, a treatment with chloride of zinc, but if the solution is strong it makes the ties brittle, while it will be a difficult matter to properly close the pores or cells to prevent the chemicals from washing out. (This statement is not in accordance with the results of extended experience.—Ed.). If the chlorine, as an antiseptic,and the coal-tar products as a preservative medium, could be combined in a form readily absorbed by the road without the intervention of expensive plants, and which could be applied by unskilled labor at the place of using, there would not be much more to desire.

The German railways have made estensive use of the zinc-creosote process, and Mr. W. W. Curtis. M. Am. Soc. C. E., in a recent article published in Engineering News, says: "Beginning in 1895, all the pine ties used on the Prussian State Railways were treated with the zinc-creosote process. It is claimed that the results are much superior to those with chloride of zinc alone." A zinc-creosote compound, sold under the name of "carbolineum-avenarius," has shown good results, and it would be economy to use it on railways in New England.

M. C. Hamilton, L. Curtis, E. E. Stone.

On Sept. 27, the meeting opened at 9:30 a. m., and Mr. W. F. Ellis presented a brief statement regarding the increase in weight of rails and weight of locomotives and cars, and discoursing the deflection of light rails with imperfectly tamped ties under heavy loads. He showed a number of sections of light and heavy rails, and said that modern heavy rails are rolled too hot and do not give as good service as older and lighter, but better rolled rails. From an economical point of view he thought that 85-lb. rails were superior to 100-lb. rails, the extra cost of the latter not being warranted by the results obtained from their use. He considered that 16 or 17 ties would be sufficient for 85-lb. rails.

Mr. Haskell said that the 95-lb. rail of the Boston & Albany R. R. is satisfactory, but would be better if made higher and more rigid, which is the universal criticism of this particular rail. The ties are 7 to 9 ins. wide on the face. Mr. Collins said that 16 ties to a 30-ft. rail were used until two years ago, when the number was increased to 18, in consequence of the narrower face of the ties now obtained. Mr. Ware (Buff., Roch. & Pitts. R. R.) said that he uses 14 ties, 8 ins. wide, to a 30 ft. length for rails of 80 and 100-lbs. Mr. Clark said that the increase in weight from 56 to 75 lbs. per yd. had reduced the labor of maintenance in surfacing and lining 33%.

Mr. J. H. Nichol, Asst. Engineer of the West Jersey & Seashore Ry., then gave some particulars of the process of sprinkling gravel ballast with oil, as introduced by him about two years ago, and Mr. S. Kunisawa, of the Engineering Department of the Japanese Government Railways, then gave a brief description of the growth and construction of railways in Japan, and particulars of the system of maintenance.

The next business was the selection of the place for the next meeting, and Philadephia, Pa., was the only place nominated. The convention then adjourned.

In the afternoon there was a steamboat excursion among the islands of Casco Bay, and in the evening Mr. E. E. Russell Tratman, Assoc. M. Am. Soc. C. E. (Associate Editor of Engineering News), delivered an address on "The Organization of the Maintenance of Way Department."

On Sept. 28, the party left Portland at 7.30 a. m. on a special train for a trip to the Rangelay Lakes, by way of the Maine Central R. R. and the Portland & Rumford Falls R. R. to Bemis, and thence by steamer across Lake Mooselucmegantic to the Mooselucmegantic House, where dinner was served. The return trip was over the same route, the train arriving in Portland at 6 p. m. On Sept. 29, a special train of the Maine Central R. R. left Portland at 7.30 a. m. for the White Mountains, going through the famous Crawford Notch to Fabyan's, where dinner was served. This concluded the programme of excursions, some of the party going back on the special to Boston, and others departing for their homes or making a trip up the Mount Washington rack railway.