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THE EIGHT-TRACK DRAWBRIDGE which is to cross the Chicago drainage canal near Campbell Ave. is meeting with continued delay and opposition. A review of the history of this proposed great structure up to the final rejection of plans for a swing bridge was given in our issue of April 7. Since then new bids have been received and a contract awarded to the Scherzer Rolling Lift Bridge Co., but an injunction has now been granted to prevent this contract from being carried out. The chief engineer of the sanitary district estimated that the ultimate cost to the district, including a capitalization for payment to the railways of the cost of operation, maintenance, repairs and depreciation, would be about $915,000, as compared with $690,000 for a bridge of the type proposed by Mr. C. L. Strobel. This latter design, however, is entirely new and provides for a center pier 8 ft. wide, with two waterways 80 ft. wide, and the engineers of the railways interested estimate its ultimate cost at $1,069,393 instead of $690,000. The Scherzer bridge would give a clear waterway of 120 ft. (originally planned for 150 ft.), and would be in general similar to bridges now in successful operation in Chicago. In view of these facts and of a resolution adopted by the Trustees in favor of avoiding the use of center piers, the contract was awarded to the Scherzer design although two minority reports were presented in favor of the Strobel and Schinke designs. Suit was brought, however, to prevent the carrying out of this contract on the ground that the contract should have been awarded to Mr. Strobel as the lowest responsible bidder. The court has granted the injunction, but based its action mainly upon the methods adopted by the district in inviting bids. It was held (1) that the Trustees should have selected one of the designs in the first place, (2) that there must be a common basis for all the bids, and (3) that unless the design was selected in advance the terms and conditions were necessarily incomplete. On these grounds the court held that the award of the contract was invalid. The Trustees will appeal the case to the Supreme Court.

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THE TRACK ELEVATION of the Chicago, Burlington & Quincy R. R. from Rockwell St. to W. 48th St., will be done next spring. In the mean time the foundations and abutments are being put in for the girder bridges of the 21 subways which will be required. The distance is 2.8 miles, with four tracks throughout. Mr. G. H. Bremner is the engineer in charge of the work. The Chicago, Milwaukee & St. Paul Ry. has some very extensive and complicated track elevation now in progress at junctions involving a large number of tracks and connecting Y's. On this road all the bridge abutments for subways are of monolithic concrete, and the plate girders are set in position by means of two cars with jib cranes, the cars being placed on each side of the subway and the girders being run out on cars on the trestling which carries the temporary tracks. Mr. W. L. Webb is the engineer in charge of track elevation.

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THE HAVANA FLOATING DRY-DOCK, including its elaborate machinery, is said to have cost Spain about $4,000,000. It is capable of lifting a 10,000-ton vessel, and was towed from Newcastle-on-Tyne to Havana. At the latter point and during the tests of the dock unskilful manipulation of the machinery by the Spanish engineers resulted in the sinking of the dock; some valves failed to work, some rivets gave way and plates opened and the dock filled and sank on its side. The dock was raised, however, by an English engineer after considerable trouble owing to the mud in the harbor. The Spanish Government would doubtless dispose of this dock at a sacrifice under present conditions, and it is said that the harbor authorities of Kingston, Jamaica, are after it. Kingston now has a floating dock of 3,000 tons capacity; this Havana dock has actually lifted an 8,900-ton ship, and can raise a 10,000-ton ship. The Spanish dock charges are excessive, as they amount to 45 cts. per ton for the first 24 hours and 25 cts. per ton for each subsequent 24 hours or parts thereof.

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THE GROWTH OF THE U. S. NAVY is rapid at the present time, as 55 warships are now under contract and 20 are nearly completed. Of the 55 ships, 8 are first-class battleships, 38 are torpedo boats and destroyers, 4 are monitors and one is a heavy armored cruiser. Of the 20 nearly finished 17 have been launched and the other three will be afloat before the end of the year. Naval Constructor Hichborn, in a late report, says that the five battleships launched are respectively 68, 66, 55, 63 and 50% completed. The cruiser "Albany," bought from Brazil with the "New Orleans," is still under construction at the Armstrong yard in England; work on her was stopped during the war, but the builders promise to deliver her within six months. A number of the torpedo boats and destroyers contracted for are well on the way towards completion.

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A RIVAL NICARAGUA CANAL COMPANY is trying to obtain a concession from the Government of Nicaragua, according to recent press reports from Managua, the capital of Nicaragua. These state that Edwin F. Crogin, of Chicago, and Edwin Eyer and Frank J. Washburn, of New York, are negotiating with President Zeloya and his Ministers with reference to obtaining a new concession for an interoceanic canal. According to the same authority the Nicaraguan Government holds that the concession granted to the Maritime Canal Co., of Nicaragua, expires during the present month, the company having failed to begin active work on the canal within the limit of time prescribed in its charter. The company claims however, that the charter does not expire until October, 1899, and, further, that as Nicaragua has not furnished the police force which it agreed to provide to guard the company's stores, property, etc., the company is entitled to a further extension of time.

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THE LOSS OF THE STEAMER "MOHEGAN" off the Lizard, England, on the evening of October 14, is one of the most serious marine disasters in recent years. The latest accounts state that 116 of the passengers and crew were lost, and only forty-five were saved. The vessel was bound from London to New York, and, as far as can at present be learned, when off the Lizard, between The Manacles and the Lowlands, ran onto the rocks. Lifeboats put off from the shore, and every possible effort was made to save those on board, but, owing to the extremely rough weather, only partial assistance could be rendered. The early reports stated that the engines broke down and that the vessel was blown ashore, but it now appears that she was out of her course. The "Mohegan" was a single screw steamer, 480 ft. long, 52 ft. beam and 36 ft. deep, with a carrying capacity of 8,500 tons and a displacement of 15,500 tons. She had stalls for 700 cattle, and was equipped to carry 125 first cabin passengers. She was built at Hull, and made her first trip in the summer of 1897, being at that time one of the freight steamers of the Wilson & Furness-Leyland Line. Later the Atlantic Transport Line bought the Wilson fleet, including the "Mohegan."

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A RAILWAY COLLISION in England, in which an express train ran into a freight train, which was switched across the main track, occurred on October 17, at Barnet, about eleven miles north of London. Nine persons were killed and thirteen were seriously injured, while a number of others received minor injuries.

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A WROUGHT IRON STAND-PIPE BURST at Waco, Tex., on Oct. 6. It is said that the pipe was full of water at the time, and that the break occurred midway in its height. According to "The Manual of American Water-Works" for 1897, the Bell Water Co., to which the structure belonged, had two pipes, one 20 × 80 and the other 20 × 88 ft.

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THE EFFECT OF THE CHICAGO DRAINAGE CANAL upon the water supply of St. Louis is again agitating the people of the latter city. It is said that the St. Louis Board of Health and a committee representing the Merchants' Exchange are discussing the possibilities of federal interference to prevent the use of the canal as designed; also that an attempt will be made to secure the co-operation of Illinois towns to prevent the use of the canal without proper dilution of the sewage with lake water.

PLANS FOR STORM SEWERS AT DENVER, estimated to cost $400,000, have been adopted, and contracts for the work will probably be let on Dec. 15. The largest sewer will be 81 ins. in diameter. The plan contemplates the drainage of 2,100 acres of land at an ultimate cost of $1,000,000. Mr. S. N. Wood is President of the Board of Public Works. Mr. Harvey C. Lowrie, M. Am. Soc. C. E., is the designing engineer.

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A JOINT OUTLET SEWER for South Orange, Milburn, Irvington, a portion of Newark, and a number of other New Jersey municipalities is being investigated by the places named. Mr. Alex. Potter, Assoc. M. Am. Soc. C. E., is making engineering studies for the scheme.

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THE MUNICIPAL ELECTRIC LIGHTING PLANT at Grand Rapids, Mich., will have the old-fashioned system of belted machinery instead of the more modern and more economical system of direct-connected machinery. This is contrary to the advice of the consulting engineers and due to the interference of some of the local authorities who have no technical knowledge whatever, and whose interference will result in increased expenditure on the part of the city. The plant as first designed by the engineers called for the direct-connected system, with engines running at 400 revolutions per minute. The claim was made by some of the bidders, however, that only the Willans engine could make that speed, and only the Western electric dynamos were built for the same speed. They therefore complained that there could be no competition. In spite of the fact that the engineers showed a great economy for the direct-connected system the local authorities rejected their advice and decided to advertise for new bids under different specifications, permitting of a very wide range of competition. While the former plan would have required a power house only 28 ft. wide the belted plant now decided upon will require a building 56 ft. wide. The cost of operation of the new municipal plant is estimated at $35 per lamp (or even less when the number of lamps is increased), while that of the old company plant was $97 per lamp. The old tower system of lighting will be retained, but the lamps will be of the Adams & Bagnall enclosed arc type. The contract has been awarded to the Chase Construction Co., of Detroit, Mich., for $90,000. This includes the pole line, 500 lamps, Russell engines, dynamos and Babcock & Wilcox boilers with the Hawley down-draft furnace. Nagle & Ball, of Chicago, are the consulting engineers.

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ASPHALT PAVING IN NEW YORK, about which there is just now considerable political controversy, is said to have cost nearly $1.00 per yard more, under Mayor Strong's administration, than similar pavement cost in other cities. The price paid in New York was generally about $3.10, and as low as $2.55 per yard. But the officials of the late Board of Public Works explain that with this price went a guarantee to keep the pavement in repair for 15 years without cost to the city. The city retained 30% of the contractors' pay for five years, and then paid this balance in ten yearly installments. If the company failed to make the repairs the city had them made, and charged the expense against the money retained. As a result the paving company could only figure on 70% of the contract price as ever coming to it, or $2.17 per yard. Practically all of the balance will be required to keep the pavement in repair for 15 years. To compare the $3.10, therefore, with work done in other cities with a shorter time-repair guarantee or no guarantee at all, and with light street traffic compared with New York, is evidently unfair. In New York other conditions also call for a relative higher price per yard. The grading of the street requires the removal of from 12 to 18 ins. in depth of soil, and to get rid of this dirt costs from 50 to 60 cts. for every square yard of asphalt laid. In other cities this cost may range from 8 to 15 cts. Long hauls, high rental of real estate and high prices for labor also tend to increase the cost of paving in New York city as compared with other cities.

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STREET CAR FENDERS are at last being introduced in Chicago after prolonged litigation between the railway companies and the city. The companies have fought several ordnances on legal technicalities, and have made the long-disproved claim that the stop planks set across in front of the wheels were more efficient than any fenders on the front of the car. The North Side cars are now being equipped with a fender composed of steel strips curving out in front of the dashboard and projecting over the track, but it is noted that in many cases the lower edge is set too high above the level of the paving.

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THE OPERATIONS OF THE ENGINEER CORPS, U. S. A., during the war with Spain, were reported upon to the War Investigation Commission by Gen. John M. Wilson, Chief of Engineers, U. S. A., in answer to specific questions. Gen. Wilson said that the expenditure for work on coast fortifications aggregated $4,821,500. Submarine mines to the number of 1,535 were planted in 28 different harbors, together with all their cables, anchors and electrical connections. Including additional mines and accessories, force of skilled electricians, fleet of tugs, detachments of engineers, etc., the expenditures on account of torpedo harbor defences amounted to about $1.661,000.

THE FAILURE OF THE SNAKE RAVINE DAM, TURLOCK IRRIGATION DISTRICT, CALIFORNIA.

By J. B. Lippincott.[*]

The Turlock Irrigation District, located in the San Joaquin Valley, in Stanislaus Co., Cal., is organized under the California law for the purpose of irrigating the semi-arid lands of the state. This law (known as the Wright Act) was passed in 1887, and has been the subject of such endless litigation that it is sometimes referred to as "the Wright Litigation Act," instead of the Wright Irrigation Act. It provides, in short, that a majority of freeholders living in any given neighborhood may define a "district" for purposes of irrigation, submitting their proposition to the County Board of Supervisors, who may then at their discretion call an election at which officers and bonds are to be voted for by all electors residing within the defined limits of the district. The bonds require a two-thirds vote to carry. These bonds, when passed, become a first lien on all lands. The officers, who are usually local farmers, or store-keepers, administer all finances and physical features of the district without any supervision save by injunction of the courts. They decide on the legality, quality and quantity of the water supply and the character of all works. Engineers and attorneys are employed by the district, but the directors pass the final judgment on all points. Landholders on the outer edges of the district may be excluded upon request, but no holder residing entirely within the lines can withdraw. The bonds frequently aggregate $20 to $30 per acre, and a failure of the enterprise means the ruin of all interests. In a few cases where the districts have exchanged bonds for existing plants the result has been satisfactory, but in over 90% of the districts, lack of judgment and endless litigation with large landholders has blighted all hopes. It would be as reasonable a proposition to give the ordinary granger a surgeon's knife and tell him to operate in a dissecting room as to be a combined banker and engineer over works that cost hundreds of thousands of dollars. If this work must be done in a communistic way, it should surely be under a very strong state financial and engineering supervision, which should ensure: (1) The rejection of enterprises without physical merit; and (2) upon endorsement by the state the full face value of the bonds. The central idea of common ownership of irrigation water by the consumers is a good one, but lack of proper detail has condemned the Wright Act as one of the blackest errors on our legal code. Defective engineering works and litigation directly reduces the market value of the district bonds, and, therefore, proportionately increases the actual cost of the work.

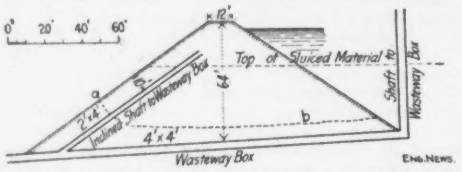

FIG. 1.—Improper Use of the Hydraulic Method of Dam Building—Turlock Irrigation District, California.

Mr. L. M. Holt, Secretary of the convention of irrigation districts, held in Sacramento, Jan. 6, 1893, stated publicly that out of 38 irrigation districts then in existence, 19 reported having voted bonds to the extent of $11,834,000. Out of this, bonds amounting to $2,622,000 had been sold for cash and $2,995,200 had been traded for water rights, making in all $5,617,200 of bonds disposed of, a little less than one-half the amount voted by the 19 districts. Thirteen other districts had voted bonds amounting to $4,942,000, none of these being sold. These 32 districts which had voted bonds contained 1,830,769 acres, and the bonds averaged $9.16 per acre. The 38 districts then in existence contained 2,149,069 acres. Out of this number 28 districts, containing 1,515,594 acres, had an assessed valuation of $39,982,849, the assessed valuation being thus $26.38 per acre.

Such a district is the Turlock, and from this prelude the two failures of the Snake ravine dam, described below, may be largely explained. The "District" contains 176,210 acres, and has voted $1,200,000 in bonds for the construction of its works. A contract was given for the delivery of the water by the contractor to the "District," and at his own cost, to make good all failure in the works.

FIG. 2.—PROPER USE OF THE HYDRAULIC METHOD OF DAM BUILDING—LA MESA DAM, NEAR SAN DIEGO, CAL.

The purpose of the dam across Snake ravine was to save the construction of 1,500 ft. of side hill canal and flume. The canal, with a capacity of 1,500 cu. ft. per sec., is designed to discharge into the basin above the dam, which basin would act as an enlarged section of conduit. At the western upper end of this reservoir the canal passes through a divide with a maximum cutting of 50 ft., and length of 800 ft. The material was an auriferous gravel in sizes from 1 in. to 2 ft. in diameter, imbedded in red clay with some sand. In original position it is extremely firm and impervious, standing when mined for years in walls nearly vertical, as high as 50 ft. A hydraulic mining canal of 24 sec. ft. capacity, 100 ft. above the grade of the irrigation canal and one-fourth mile distant, furnished existing conditions which were ideal for the construction of an earth dam by the hydraulic process.

The plan was to make the dam from material from the big cut. The opening to be closed is 294 ft. long and 64 ft. maximum central depth. The top of the dam was 4 ft. above the maximum water line. The top width was 12 ft., and the slopes between 1½ to 1 and 2 to 1, which is lighter than is called for in good practice. The first dam was built in 1893, and went out when it had reached the 30-ft. level. The second dam went out when first tested, on June 14, 1898. The second dam was built upon the wreck of the first, and in the same manner.

Hydraulic mining in the ravine had deposited "tailings" at the dam site. These were never removed, or the bed-rock explored. A section of the dam is shown by Fig. 1.

The plan of the work was to build up the lower toe of the dam with scrapers and keep it all the time at an elevation of 2 ft. or more above the remaining portion of the dam, as shown by the lower dotted line, a b. Material was then washed down with a hydraulic jet at the big cut or from the adjoining side hills of the basin and sluiced to the dam site in the natural water courses.

The inclined shaft was built as the work progressed, its top opening being kept below the lower dike, as shown at a, and above the line a b. It was 2 × 4 ft. in the clear; the water carrying the earth in suspension would be stilled in the pond above a, deposit its load, and waste from its clarified surface through the inclined shaft. The purpose of the sand box, or vertical shaft, was an additional waste to draw down the water level in the reservoir when desired. The result of this procedure is obvious. The material from the bank instead of being carried in a homogenous mass, as would have been the case if conveyed in a flume or large pipe from the working face to the dam, segregated itself, boulders, gravel, sand and clay being progressively deposited from the cut to the dam. The basin was filled with many hundred yards of material that never reached the dam. The material that actually got in place in the dam was a very fine clay or silt which could not drain itself, and which remained slimy and slippery until the dam went out. The dam was stratified throughout, layers of this silt in some way being followed by layers of pure sand.

The first dam was constantly shaky and wet, vibrating when jarred. It slid out when 30 ft high. The effort was made to "use more care" in the second structure, but, in a general way, the same method of work was followed. The waste box in the bottom of the dam was built 4 × 4 ft. in the clear, of 2-in. Oregon pine on two longitudinal 6 × 8-in. stringers as sills. There were no corner or central bracings. When the dam reached a height of 40 ft. it crushed in this box and prevented its further use as a wasteway. The dam was then finished by hauling the material deposited above the dam into position with carts. The dam leaked badly. With a few feet of water in the basin a stream of 1 cu. ft. per sec. passed under the dam, issuing from the broken waste box. This at first ran muddy and carried considerable sediment. Later this water became less in quantity and clearer. This was caused by sluicing in material from the side hill, above the dam, which closed the pores in the debris above and under the dam. There was more leakage through the material that was deposited by carts than through the stratified material that was sluiced into position.

It was optional with the contractor whether he should put in a flume across the ravine or build the dam. When the dam was decided upon it is said that the contractor rejected the request of the officers of the district, both as to its location and method of its construction, and, therefore, the loss falls entirely upon him.

The intake canal passes near the east end of the dam and a wooden box 4 × 4 ft. for a new wasteway was put in the west end of the dam 10 ft. below the top. The intake canal is located on a steep hillside. It soon leaked and sloughed off a piece of the side hill immediately next to the dam, which then began to leak around that end. The waste box, which was also leaking, was then opened on the west end and washed out a large hole from the side hill and dam on its lower side. The dam was leaking at its foundation also. Attacked on both flanks and center, the entire structure gave way. It was pushed en masse down the ravine at a velocity of from 6 to 10 ft. per sec., and thrown into the Tuolumne River. The total distance traveled was over 1,000 ft. It temporarily dammed the river to a depth of 20 ft. The Superintendent and two dogs were on the dam when it gave way. They all were carried entirely across the river and none of them hurt, though the man's shirt and

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[*] U. S. Geological Survey, Los Angeles, Cal.

pockets were filled with sand and mud on his trip. The ravine is now to be crossed by a flume.

Dams have been most successfully built by the hydraulic process elsewhere. The method is well described under "Reservoirs for Irrigation," XVIII., Geological Survey Report, by Jas. D. Schuyler, M. Am. Soc. C. E. Fig. 2 shows the construction of La Mesa dam, near San Diego, by the hydraulic process. This work has proved both economical and efficient and shows the proper method of handling the material. In this case a clay and gravel soil is being stripped from a hard pan and conveyed through an iron pipe to the dam site. The sluicing stream is so located as to erode rapidly, the clay and gravel and this material is also thrown into it by plowing and picking. The feature of this class of work is its economy, and when well done it should produce the very best class of earthwork. The method is being used extensively in the far Northwest in putting in large railroad fills at a cost of from 3 to 10 cts. per cu. yd., depending largely on the location and quantity of the water supply.

As an interesting demonstration of how not to do it, the history of the Snake ravine dam is unique.

* * *

PROGRESS ON THE NEW CROTON DAM.

(With full-page plate.)

After nearly six years of work on the part of the contractor for the new Croton dam, some portions of the masonry of the main structure are now up to a point slightly above elevation 50, about the original bed of the river. All of this part of the work has reached the zero level, or average mean tide at Sing Sing, 30 miles from New York. Although the masonry already built is 140 ft. in maximum height, the working levels are still spoken of as "the hole." In its greatest cross-section this immense dam will be 290.8 ft. high and 216 ft. wide at the base. These figures exceed the preliminary designs, owing to the fact that it was necessary to go deeper at one or two points than had been expected, the maximum depth reaching elevation — 80.7, or 130.7 ft. below the old river bed. A total of about 270,000 cu. yds. of masonry had been laid up to Aug. 1, 1898. All but about 100 ft. of the foundation for the heart-wall was in place when a representative of the editorial staff of this journal visited the dam on Aug. 23, and only some 250 ft. of the foundation for the spillway were still lacking at that time.

A typical section of the dam, showing the depths of the rock excavation at various points, is shown by Fig. 1. Views of the work at different stages of its progress since the beginning of 1896 are shown by Figs. 2 to 5, inclusive.

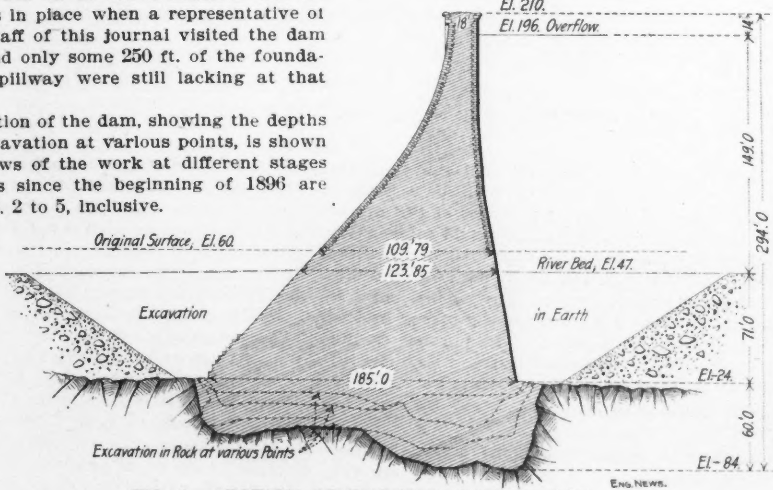

FIG. 1.—SECTION OF THE NEW CROTON DAM.

A full illustrated description of the new Croton dam was published in Engineering News for June 2, 1892, and the detailed bids for the structure were given in our issue of Sept. 5, 1892, under "Contract Prices." For the convenience of the readers of this article some of the information in these earlier issues will be repeated here. The new dam is located about 3.1 miles below the original Croton dam, and 3¼ miles above the point where the Croton River discharges into the Hudson. The dam site, in relation to the Croton drainage area, was shown in our issue of Nov. 22, 1890. The dam is divided into three parts: (1) A masonry structure about 700 ft. long and 18 ft. wide on top; (2) an earth embankment with masonry heart-wall joining the masonry at the south, some 500 ft. long; and (3), a masonry spillway about 1,050 ft. long, nearly at right angles with the main dam. The heart-wall and spillway wall, together with the main dam, form a continuous masonry wall across the valley.

The contractors for the dam complete are Coleman, Breuchaud & Coleman, of New York city. The preliminary estimates of quantities, together with the engineers' estimates of unit prices and the contractors' bid for the work, are reprinted from our issue of Sept. 8, 1892, as follows:

Quantities.			Eng'rs estimate.	Contract price. Rate.	Contract price. Amount.
Excavation:					
Soil and placing	2,000	cu. yds.	$0.35	$0.50	$1,000
Earth	550,000	" "	.50	.61	335,506
Earth, vert. trenches	35,000	" "	1.25	.95	33,250
Rock	300,000	" "	1.50	1.95	585,000
Sodding	10,000	" "	.30	.30	3,000
Refill and embnkmnt.	900,000	" "	.30	.25	225,000
Earth hauled, 3%	150,000	" "	.009	.0075	1,125
Permanent timbr wrk	200	M. ft.	40.00	40.00	8,000
Tongued & grooved.	120	" "	45.00	45.00	5,400
Cribwork	8,000	cu. yds.	2.50	3.00	24,000
Portland cement	1,000	bbls.	3.00	3.00	3,000
Concrete (Am. cemt.).	10,000	cu. yds.	4.50	4.55	45,500
(Portland cement)	3,000	" "	5.94	6.006	18,018
Masonry: Brick	2,000	" "	12.00	10.00	20,000
Block stone	2,500	" "	15.00	15.00	37,500
Granite dim. stone.	2,500	" "	30.00	35.00	87,500
Facing stone	24,000	" "	15.00	13.50	324,000
Rubble: Dry	12,000	" "	2.50	2.50	30,000
(Am. cem., 2 to 1).	470,000	" "	5.00	4.05	1,903,500
(Port. cem., 2 to 1).	30,000	" "	6.60	5.346	160,380
(Port. cem., 3 to 1).	50,000	" "	6.00	4.944	247,050
Riprap	5,000	" "	1.50	1.75	8,750
Broken stone	10,000	" "	1.50	1.50	15,000
Face work for rubble.	15,000	sq. ft.	.30	.40	6,000
Face dressing:					
Fine ham'r'd (6-cut)	22,000	" "	.75	.65	14,300
Rough pointed	12,000	" "	.40	.40	4,800
Highway fence	8,000	lin. ft.	.50	.50	4,000

The final estimates thus far, as compared with the preliminary estimates, indicate an increase in earth excavation and masonry, and decrease in embankment and earth excavation in vertical trenches.

The new dam will have a storage capacity of about 32,000,000,000 gallons, giving, with the other reservoirs completed, or under construction, a combined available storage capacity of about 72,000,000,000 gallons. The drainage area tributary to the new reservoir is about 360 sq. miles, and the run-off for the driest year from 1870 to 1895, inclusive, was about 15 ins. in depth, or 700,000 gallons per sq. mile. If none of this were lost it would afford an average minimum daily supply of about 250,000,000 gallons. With the new storage completed the average daily supply in a dry year will be 280,000,000 gallons.

The reservoir formed by the new dam will be about 18 miles long, overtopping the crest of the overfall of the old Croton dam to a depth of about 30 ft., and that portion of the old aqueduct between the old and the new dams to a depth of about 35 ft. above the crown of the arch. It is desired to send water back to the new gate-house at the old dam, through this submerged portion of the old aqueduct, in order to prevent the lower portion of the lake from becoming a dead end. This raises the question of the effect upon the old aqueduct embankment of lowering the lake so as to expose the embankment after it has been flooded. The subject is now being studied. There has been talk of reinforcing the old embankment and of laying pipes in this stretch of the aqueduct.

The principal change in the original plans for the new dam has been the making of the masonry portion some 115 ft. longer, and the consequent shortening of the earth embankment. This was due to a variety of reasons, one being the desirability of decreasing the height of the embankment, and another to limit the heart-wall to the stretch of hard pan reaching to bed rock. Where the hard pan has been found it has been a most excellent material in which to place the heart-wall. The masonry throughout the whole structure, it hardly seems necessary to say, is carried down to the solid rock.

In backfilling about the heart-wall every stick of timber is removed and the hard pan material replaced in 4-in. layers, wet and rammed. At first 6-in. layers were used, but great care is necessary to prevent the material from becoming jelly-like, and the 4-in. layers have been found to give the best results.

The immense trench to rock bottom for the foundations of the dam was excavated by means of steam shovels, the spoil being removed in cars on light railways. The stone for the masonry is a very heavy dark granite weighing 185 lbs. per cu. ft., quarried about 1½ miles above the dam. The sand for the cement mortar is obtained from the old river bed about a mile above the dam. Natural cement is being used for the rubble work composing the bulk of the masonry, and Portland cement may be used for the facing stone, the parts being 2 to 1 and 3 to 1, respectively. No faced stone has yet been laid on the main dam. The masonry is being carried up in benches about 15 ft. high, the approximate elevations on Aug. 23 being 0 in the center, 45 ft. at the north end, and 60 ft. at the south end. The faces are now being stepped by courses, but so as to bring the steps entirely outside the neat line of the cross-section.

In laying the masonry every block is lifted at least once. This gives an impression of the stone on the bed, and allows the latter to be dressed up as needed. Most of the masons have worked on the other dams, built in the drainage area by the Croton Aqueduct Commission. Many of them are Italians. In exceptional months the masons have averaged nine cu. yds. of masonry per day per man for entire months. Nearly all the rock is brought to the works on light railways located on each side of the dam, being shifted from the cars to the benches by derricks and also put in place by derricks. There are three cableways extending the length of the dam, one a Lidgerwood and the other two, Trenton. These are used principally for handling sand, cement and spawls, and for shifting the derricks, being especially handy for the latter work.

Work is carried on by night as well as by day, the night shifts working on back-filling. The back-filling against the main dam is kept well wetted. Thus far it has not been rolled or tamped, but it will be later on.

Most of the water encountered has been on the upper side of the dam. This is lifted over the masonry by means of centrifugal pumps, where it and the water from below is repumped to the new river channel. For the second pumping three 4,000,000-gallon Worthington pumps have been provided, but except after rains one of these is able to handle all the water upon emergency. A number of springs have been struck, one being a very large one. These have all been piped and eventually the pipes will be filled with grout.

The river has been diverted from its old channel by means of dams of earth and crib-work and a masonry wall. The new channel is 125 ft. wide, and during one freshet was filled to a depth of about 11 ft., the rate of flow being about 9 or 10 miles an hour.

A feature of the gate-houses at the new dam is iron guides for the stop planks, formed of channels, with exterior plates or webs to bind them into the masonry. It has been found that the heavy stop planks sometimes catch on the joints of the ordinary granite grooves.

Mr. Alphonse Fteley, Pres. Am. Soc. C. E., is Chief Engineer of the Croton Aqueduct Commission. Mr. Charles S. Gowen, M. Am. Soc. C. E., is the Division Engineer in charge of construction at the new dam, and Mr. B. R. Value is Assistant Engineer on the work. We are indebted to each of these gentlemen for courtesies and aid extended in the prepartion of this article.

A NEW RAIL SPLICE AND AN ANTI-CREEPER FOR STEAM RAILWAY TRACKS.

We illustrate herewith a new rail-joint which has recently been put into use on the Pennsylvania Railroad, and which seems to possess in an unusual degree the strength, stiffness and simplicity of construction which are now generally recognized to be the essential features of a successful rail-joint.

As every engineer who has given attention to the rail-joint problem knows, the perfect rail-joint must give to the two ends of the rail which it holds the same stiffness to resist transverse stress that is possessed by the rail itself. The common angle-bar joint cannot secure this, by reason of the limit of height by the distance between the head and flange of the rail; and most inventors of improved rail-joints have sought to give additional support to the rail in some manner. The joint shown herewith embodies one of the simplest and most effectual plans of strengthening the angle-bar that has ever been devised. It is also so designed to be simple and economical in manufacture, and to give the greatest strength with the least material employed. The two parts forming the splice have a combined section from 20 to 30% greater than that of the rail to be spliced, and the parts are rolled in practically the same form and in the same manner as the ordinary angle-bar, except that the flange of the bar is made about 3 ins. wider than usual. After it is rolled and cut into proper lengths, the plate is reheated and is then pressed by dies into the form shown in the illustration. The result is a largely increased bearing on the tie, and a deep and strong truss under the rail-joint, with gusset-plates connecting the depending flange and the horizontal, or bearing flanges. The value of this gusset-connection is especially marked, as it obviates all danger of the movement of the depending flange, either inward or outward, under applied loads; as has occurred in somewhat similar splice-plates where the lower flange was simply cut twice and turned down. This splice is simple, strong, economical and rigid, with single parts only for each splice-plate. There are no bolts or parts under the joint to be manipulated; a feature that will be appreciated by all trackmen.

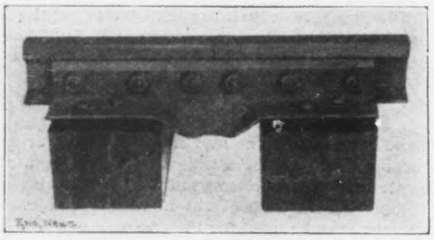

Fig. 1.—A New Rail Joint.
A. Bonzano, M. Am. Soc. C. E., Inventor.

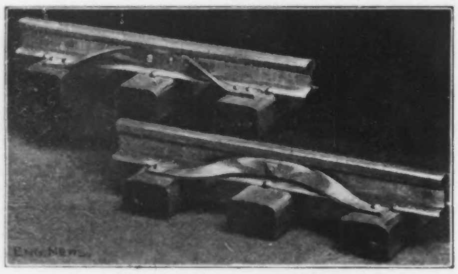

Fig. 2.—Device for Preventing Rails from Creeping.
Designed by A. Bonzano.

This rail-splice has now been in regular service for some months on three miles of the main line of the Pennsylvania R. R., west of Harrisburg, Pa.; and Mr. Joseph T. Richards, Engineer of Maintenance of Way, authorizes the statement that trains run so smoothly over this section that the rail-joints cannot be noted. Computations show that this joint has 1.08% of the stiffness of the rail itself; or, in other words, is somewhat stronger than the rail, and the rail is thus practically continuous. It is also shown that a track equipped with 70-lb. rail and this splice is equal in service to an 80-lb. rail fitted with the ordinary angle-bar splices. According to Mr. Richards the ordinary angle-bar joint is only from 28 to 32% as strong as the rail.

The creeping of rails under traffic presents another serious railway problem that has not yet been satisfactorily solved. But that some efficient method of preventing this creeping is imperatively demanded is made evident in battered rail-heads, wear and annoyance of jolting over open joints, and in the derailments caused by the vertical or horizontal deviation from track line resulting from the crowding together of rails under this creeping movement.

In the anti-creeper here described, the inventor proposes to firmly anchor each rail to the roadbed; where it is free to contract or expand within its own length, but cannot "creep," or concentrate at any one point the movement of a large number of rails. It is this latter feature that causes all the trouble. The device is so simple that it is remarkable that it has not been sooner applied. It is a metal bar, about 2¼ × ⅝-in., of sufficient length to be spiked, or secured by screw-bolts, to two cross-ties, preferably, with one tie intervening. The middle of this bar is bent at right angles to the ends, so as to fit the web of the rail, and it practically forms a bracket with either half acting as a strut or a tie according to the direction of the stress. The crossties embedded in the ballasted roadbed form a firm anchor, and the advantages claimed are that the distances between the rail-heads will be uniformly maintained; no bending or shearing of the splice-bolts is possible—and this alone would compensate for the cost of the bars; the rails cannot crowd together, and they will remain in position at frogs, switches and cross-overs, on draw-spans, trestles, etc., exactly as they were originally placed by the trackmen with much labor. The purpose of the anti-creeper is to save wear in track material, to decrease track labor, and to obviate as much as possible the danger from derailment from creeping rails.

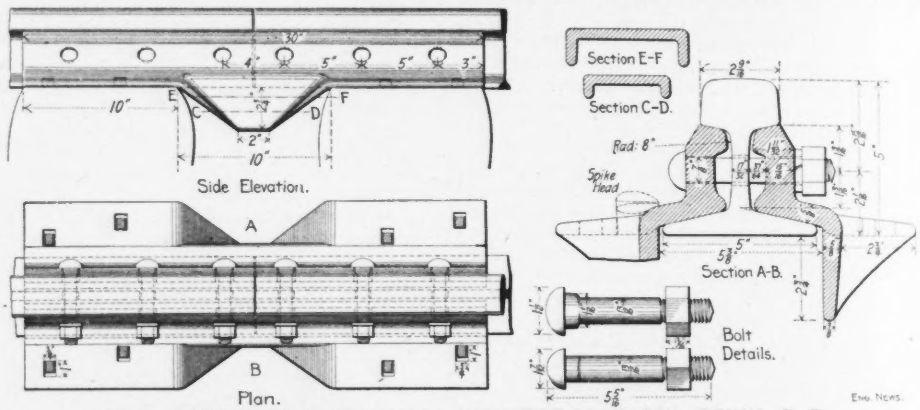

FIG. 3.—DETAILS OF BONZANO RAIL JOINT FOR 85-LB. RAIL, PENNA. R. R.

According to estimates submitted for applying this anti-creeper to five miles of track on the Pennsylvania Railroad, the cost for one rail is 50 cts. As there is practically no wear, the life estimate is placed at 20 years, and the annual cost is thus 2½ cts.; and as the scrap is worth 20 cts., the actual cost of the anti-creeper may be put at 1½ cts. each for one year. In other words, the claim is made that for 1¼ cts. per mile per day rails may be kept in their original and exact position, and the many troubles and expenses incident to creeping may be practically eliminated.

Both the rail-splice and the anti-creeper above described are the invention of a well-known civil engineer, Mr. Adolphus Bonzano, M. Am. Soc. C. E., 331 South 18th St., Philadelphia, Pa.

* * *

THE WORLD'S COAL TRADE.

From a statement recently issued by the British Board of Trade, the following figures are taken relating to the world's production and consumption of coal, from 1883 to 1896. In the latter year the most important coal producing countries gave the following outputs:

United Kingdom	195,361,000	tons.
United States	171,416,000	"
German Empire	85,690,000	"
France	28,750,000	"
Belgium	21,252,000	"
Russian Empire	9,229,000	"
Japan	5,000,000	"
British India	3,848,000	"
Canada	3,743,000	"
Australasia	5,345,000	"
Total	529,626,000	tons.

As to comparative cost per ton at the mine, the United States delivers the coal at the cheapest rate, the figure being about $1.14 per ton. The same cost for the United Kingdom is $1.40; Germany, $1.66; France, $2.08; Belgium, $1.82; Japan, $1.20; and the average cost in Australasia is $1.62 per ton. From these figures the "British Trade Review" expects that the United States, notwithstanding the distance to the seaboard and local demand, will be able to send huge quantities to foreign countries. In 1896 the excess amount of coal exported to other countries was as follows: From United Kingdom, 44,587,000 tons; from Germany, 6,122,000 tons; from Belgium, 4,018,000 tons; from United States, 2,337,000 tons; from Japan (1895), 1,805,000 tons; from New South Wales, 2,474,000 tons, and from Natal, 90,000 tons.

The consumption of coal per head of population is, of course, largest in the countries where steam traction and machinery are most used. But in France the average consumption seems very small for a country so far advanced in civilization: it is only .98 ton per head, as compared with 2.65 tons in Belgium, and 3.82 tons in the United Kingdom. The consumption is not noted for the United States; but, deducting the export and taking the population at as much as 75,000,000, the average would be 2.25 tons per head.

An important development of the coal trade is having a place in the far East. Including the output of Chili and the British export of coal to the east of Cape Horn and west of the Cape of Good Hope, the East is now consuming nearly 25,000,000 tons of coal annually. Indian coal production is rapidly increasing, and some of the Assam coal is said to be quite as good as the best English steam coal, and the cost of raising is about one-half of the English cost. The Japanese coal deposits are not very extensive, and their competition in the Eastern market need not be greatly feared by England; and the manufactures of that country are increasing so fast that coal is even now high in cost in that country. But there are great, undeveloped possibilities in China and Siberia. On the Trans-Siberian railway fifty groups of workable coal deposits are reported upon, and the output in Eastern Siberia, particularly from the Amour valley, is now about 2,000,000 tons annually. In China, a British syndicate claims a concession, in the Shansi district, for a coal field 250 miles long and 40 miles wide; and by its side are immense deposits of brown hematite and spathic iron ores and an abundance of limestone. The development of these deposits would enormously effect the evolution of industry in the far East, and have a marked effect upon economic and industrial conditions in Great Britain, says the "Review."

A DIRECT READING POWER GAGE FOR STEAM ENGINES.

The measurement of the power developed by a steam engine has always been a difficult operation, and is rarely a completely satisfactory one, involving, as it at present does, a series of operations, each one contributing a small error to a total which amounts sometimes to a considerable figure. Several ingenious integrating indicators have been devised to measure the total work done over any period of time. One of the most successful was described in Engineering News of July 28, 1898. Practically all of these instruments depend upon the elasticity of springs and the use of pistons, and there are several mechanical limitations which restrict the use of these devices. For instance, it is not mechanically practicable to operate continuously an indicator spring through its entire range of elasticity without permanent set or crystallization; neither is it practical to operate a piston within a cylinder with a constant coefficient of friction. In the device referred to in the title of this article, a radical departure has been made and an entirely new principle is employed for the meaurement of the pressure in the cylinder. For purposes of explanation it may be spoken of as a steam turbine driven by a steam jet whose pressure is the same as, or directly proportional to, the working pressure in the engine cylinder. This will be clearer if Fig. 1, a diagrammatic illustration, is examined. The cylinder represented may belong to any kind or make of engine, the details of construction or valve mechanism playing no part so long as there are the usual indicator taps, represented in the figure by A and B. From these, short curved pipes lead into the back of the instrument, which is placed beside the cylinder at a convenient height for observation.

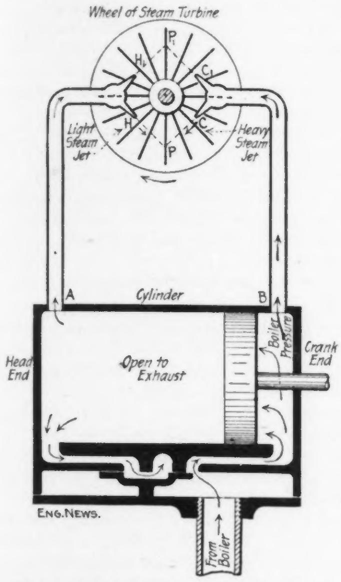

Fig. 1.—Diagram Illustrating Principle of Operation of the Atwood Power Gage.

Inside the instrument case the pipes just mentioned terminate in four nozzles, H H_1 and C C_1 shown in Figs. 1 and 2, and just back of the nozzles is a metal disk mounted upon a shaft and nicely balanced on ball bearings. This disk is provided with a series of thin radial blades set perpendicular to its surface. The nozzles H H_1 C C_1 are set at an angle, as will be seen in Fig. 1, and are inclined towards the turbine wheel, as shown in Fig. 2, so that the steam jets impinge at the two points P and P_1. In addition a simple valve or shutter arrangement cuts off the steam jets H C or H_1 C_1, as the case may be, just as the engine piston changes direction or better at the instant the steam pressures of the head and crank ends of the cylinder reverse. This jet-controlling mechanism is very simple, and is operated by a simple reducing motion.

Considering now the operation of this turbine wheel and referring to Fig. 1, it will be seen that the steam at boiler pressure is free to pass through the steam port into the crank end of the cylinder, and thence through B to the nozzle marked C (C_1 being at that instant closed by the shutter device). The steam jet issuing from C strikes the turbine wheel at P with a force which is directly proportional to the pressure in the working end of the cylinder. At the same time a jet is issuing from H, H_1 being closed, but here the pressure is that on the exhaust side. The result of these two opposing forces is a force tending to turn the turbine disk at a velocity which is at all times directly proportional to the effective pressure in the cylinder.

The disk is made of a weight sufficiently light to readily respond to the series of impulses and yet heavy enough to have sufficient inertia to integrate the impulses and maintain an approximately constant velocity, when the impulses are of equal value. In fact the turbine wheel plays exactly the same part as the flywheel of an engine, the speed of which, were there no governor upon the engine, would be a measure of the mean effective pressure. To prevent racing, and at the same time to put a constant load upon the turbine a fan consisting of several radial blades is mounted upon the turbine shaft (Fig. 2), but in a separate compartment. Directly in front of the load fan, but in no way connected to it, is another similar fan. Upon the shaft of this second fan, but in a third compartment, is mounted a dead beat or dampening device and a spiral retractile spring. The indicating needle or pointer is outside of this compartment, and swings around a dial, Fig. 3. The only connecting link between the turbine and the indicating portion is, therefore, the air in the enclosed compartment.

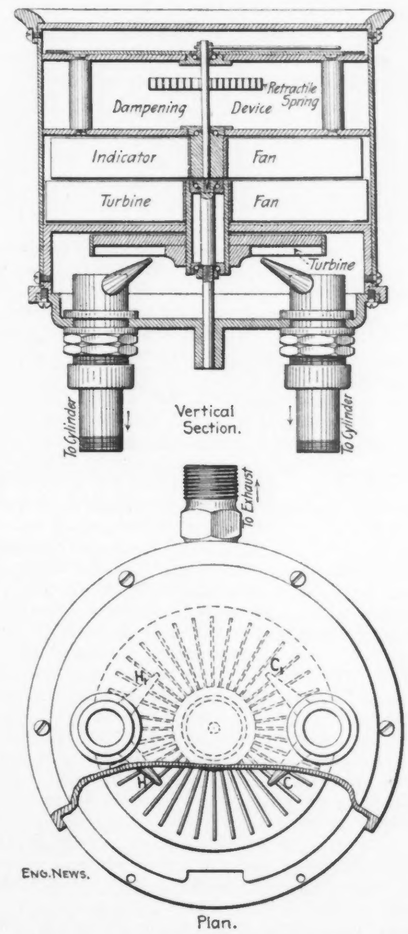

Fig. 2.—Section and Elevation of the Atwood Power Gage, Showing Arrangement of Parts.

In the operation of the instrument, the turbine revolves continuously in one direction, clockwise, with a speed ranging from a few revolutions up to 1,200 or 1,500 revolutions per minute, depending directly upon the effective pressure in the cylinder. In so doing it gives a rapid whirling motion to the air in the intermediate compartment, and this whirling air tends to turn the second fan against the resistance of the spring. Thus this fan is actually turned from its normal position a distance proportionate to the turbine speed. The dampening device prevents any sudden movement of the fan and needle.

In calibrating the instruments at the factory, two compressed air tanks are employed, one supplying each pair of nozzles. The air is compressed in these tanks by electric motor-driven compressors and a calibration can be made for any desired range of pressures. The scale on the dial can be graduated for indicated horse-power, or in the case of constant speed engines the scale may be marked for mean effective pressure on an inner scale, and the horse-power for various pressures marked on an outer scale. Other methods are possible and will suggest themselves.

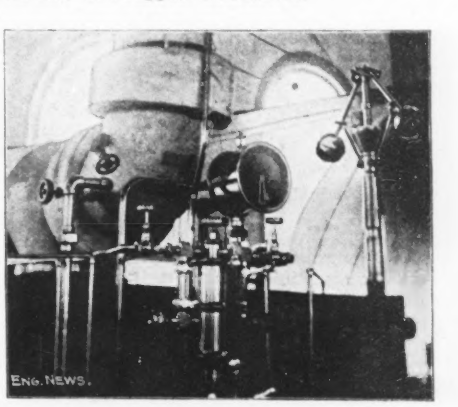

Fig. 3.—View of Engine with Atwood Power Gage Attached, Showing the Size of the Instrument.

In installing the instrument it is advisable to employ a 3-way cock at each end of the cylinder, and also in the pipe leading to the exhaust pipe. This will permit the testing of load distribution and the use of an ordinary indicator for valve adjustment should it be desired.

The possibilities and utility of the instrument are briefly as follows: It will enable an accurate and complete log of station operation to be kept; it forms a check upon the condition of the engine and will enable the efficiency of the plant to be easily determined and maintained; it forms a constant indication of valve setting, and will at any time show the distribution of work between the several cylinders or between the ends of the same cylinder. In the case of a condensing engine the operation of the condenser can be tested. Friction loads and the power required to run any one or several machines can also be readily determined, absolutely no skill being required, as the operator has only to open the valves and note the dial indication.

Several of these power gages have been in continuous operation on the engines of the Peoples' Elec. Light & Power Co., at Orange, N. J., for the past 18 months, during which time comparisons with indicator cards show a variation of less than 1%. Another instrument is at present in use on a high speed engine in the New York Telephone Building, 15 Dey St., New York city. The principal duty of this engine is to drive a generator furnishing current for several Sprague electric elevators, and a rough and ready check upon the power gage is afforded by comparing it with the switch-board ammeter. As the load is increased or decreased both needles swing out slowly in perfect unison.

This ingenious instrument is the invention of Mr. G. F. Atwood, of the Atwood Power & Speed Gage Co., 95 and 97 Liberty St., New York. We are indebted to him for the information and drawings from which our description and illustration have been prepared.

* * *

TELEGRAPH LINES IN SANTIAGO PROVINCE, Cuba, to the extent of 447 miles, have been ordered by the military authorities and are being put up under Capt. Jasper E. Brady, of the U. S. Signal Corps. These lines will connect Santiago with Manzanillo, Victoria de las Tunas, Holguin, Guantanamo and Baracoa. There is also a line from Guantanamo to Sagua Tanamo. As business increases the system will be extended. The line to Holguin and Victoria will connect with a line building eastward from Havana. American operators and American methods are employed, and any profits will be devoted to extending the lines, the same rates being charged for service as in the United States.

COUNCIL REPORT ON THE STREET RAILWAYS OF CHICAGO.

There has for a long time been strife between the street railway companies and the city authorities and the people of Chicago, over questions involving the terms of franchises, the relations of the companies to the city, and the character of service and accommodation furnished. In October, 1897, the City Council passed a resolution introduced by Mr. J. N. Harlan, directing the appointment of a special council committee to investigate the street railways, their franchises, financial operations, traffic conditions, and the wages paid to employees. The Mayor, Mr. Carter H. Harrison, was chairman of the committee. This report was presented in March, 1898, but its publication was delayed for some months, owing to a failure on the part of the city to provide an appropriation for printing. The report is lengthy and is not very well arranged, as might be expected, nor is it always quite logical, but it contains much matter of considerable interest, and it certainly shows the need of some change in the relations between the city and the street railway companies. The officers of the companies refused to furnish any information, and a certain bias against the companies is somewhat evident, but on the other hand it must be said that the city and the people of Chicago have many reasonable grounds of complaint against the street railways.

The first subject taken up for discussion is that of the franchises, and at the very outset a great difficulty was experienced, due to the fact that many of the lines are operated by lessee companies, instead of by the companies to which the franchises were granted, but that no copies of these leases were submitted to the Council for approval, or filed with the city, so that the Council might be informed as to their terms. Other difficulties arise from the fact that there is no ordinance requiring the companies to file statements as to their assets, or to furnish any other information, and that many of the franchises have been drawn up by the representatives of the companies instead of by those of the city. It is also noted that the public records contain no specific grants for some of the lines now in operation. In this respect the committee makes the following note, which contains a very important truth:

> The Metropolitan Railroad Co., of Washington, D. C., which has constructed and is operating an underground electric system probably unsurpassed anywhere in the world, makes an annual report to Congress, giving its assets, its receipts, an itemized statement of all its disbursements, and a list of all its stockholders, with the amounts of their holdings. This fact seems to indicate that openness and publicity of accounts and personnel are quite consistent with, if not distinctly conducive to, superior equipment and service.

As to the discussion of the franchises, the subject is so involved and so complicated by changes, legal quibbles, amendatory franchises, doubtful ordinances, ambiguous phraseology in the franchises, etc., that no direct line of argument can be followed out. The question of greatest importance, and the one which largely gave rise to the agitation which resulted in the appointment of this committee, was as to the time of expiration of the present franchises and the terms upon which extensions of these franchises should be granted. Most of the old franchises were for 25 years, but in 1865 the legislature passed the "ninety-nine-year act," extending the life of the three companies (operating on the North, West and South sides) and their several franchises from 25 to 99 years, or until Feb. 14, 1958. The "horse and dummy line act" of 1874, required the consent of the local authorities for the location or construction of any street railway, and provided that such consent should not be granted for a period of more than 20 years. In 1875, the city of Chicago adopted its new charter, which authorizes the city to permit, regulate and prohibit the locating, constructing or laying a track of any horse railway in any street, alley or public place, such permission not to be granted for a longer period than 20 years. These promises were undoubtedly made to prevent any future "ninety-nine year" grants, but could not affect grants already made.

In 1883, the period of the three main 25-year grants expired, and the question as to the legal effect of the ninety-nine year act came before the Council for decision. As the result of controversies over this question and that of car licenses, a compromise ordinance was passed July 30, 1883, granting the three companies an extension of time for their then existing lines until July 30, 1903, or postponing the settlement for 20 years. The committee arrives at the conclusion that these and all later grants are either terminable by the city at will on July 30, 1903, or will expire absolutely on that date, while the companies claim that the later grants do not expire until Feb. 4, 1958.

Grants for mechanical power are usually for a term of years, sometimes extending beyond the term of the original franchise, but it is not supposed that these could extend the franchises. In other cases, no duration is specified and the grants can be revoked, or would terminate with the original franchises.

The second part of the report deals with the history, operations, liabilities and profits of the three principal companies: The Chicago City Ry. Co., the North Chicago Street Ry. Co., and the West Chicago Street Ry. Co. The figures of the financial operations aim to show excessive profits by the payment of very large dividends and by the distribution to stockholders at par ($100) of stock which would sell on the market at $200 to $300. In other words, all the companies are charged with extensive watering of their stock, while they are further charged with misplacing money by means of contracts for installing mechanical traction, and building the Van Buren St. tunnel, etc., these contracts being let to construction companies composed of members of the street railway companies. The estimates of cost of all the work let under these contracts are claimed to have been very much too high. The cost of putting in the cable system on the main lines of the West Chicago Street Ry. Co. is given by that company as $8,000,000, although it gave the construction company $10,000,000 of its stock for the work. Independent estimates, however, have put the actual cost at only $5,000,000.

The committee considers that an income of 8% would be a liberal allowance, and presents tables showing the actual profits realized in excess of such an income. To ascertain these profits as realized up to any given date, the difference between the stockholders' investment and the present value of the entire stock was ascertained, and to this was added the sum of the annual excesses of dividends above 8%, these excesses being accumulated at 4% compound interest.

Another point taken up is the over-capitalization of the companies, which is derived by comparing the cost of duplication of the lines (as given by Prof. Bemis in the Report of the Illinois Bureau of Labor Statistics, 1896), with the capitalization, that is, the par value of stocks and bonds. From these figures deductions are drawn as to the payments which might have been made to the city, and the reductions in fares which might have been conceded by the companies if dividends in excess of 8% had been foregone, the reduction in fares being based on the assumption that it would not increase the number of passengers. The companies make certain annual payments to the city for car licenses, operating bridges, and public improvements, but in 1897 these payments amounted to only about $30,000 by each of the three main companies, as shown in the accompanying table, this being less than 1% of their gross receipts.

The general tenor of this part of the committee's report is that the companies are directly blamable for these conditions, but it should be borne in mind that if the city (through its representatives) has not looked out for its own interests, it is not reasonable to expect that the street railway companies will do so. The companies are not organised or operated on a philanthropic basis, but as money-making enterprises, and they cannot be expected to make payments to the city or concessions to the public which are not demanded by the terms of their franchises. It is true that it might be good policy on their part to make certain concessions, but that is a matter upon which the companies alone are the judges.

Another source of trouble which is discussed is the insufficiency of transfer privileges, by which many passengers have to pay two or more fares for comparatively short rides. This is due largely to the way in which the three sections of the city are apportioned among the three main companies, which give no transfers over each other's lines. In other cities, however, such interchange transfers are given, and have proved very satisfactory. The best system of transfers is said to be on the South Side, while on the North Side the transfers are limited. The latter case is said to be due to the fact that branches and feeder lines which should properly form a part of the main North Side system, are built and operated by separate companies which collect their own fares. These companies, however, are composed of representatives of the main company, which thus practically receives both fares.

Another curious fact in regard to transfers is that the first street railway grant was to the Chicago City Ry. Co., for a line running east and west on Madison St., from Western Ave. to State St., and north and south on State St., from Lake to 31st St. The ordinances for this and later lines extending from the South Side through the city to the West Side, required that the rate of fare for any distance should not exceed 5 cts. In 1863, however, the company sold its Madison St. line and all West Side lines to another company, and since then separate fares are required on the West Side and South Side lines, although the original requirement for a single fare has never been legally repealed, nor has the sale been approved by the city.

The three main street railway systems terminate in the business center of the city, and passengers going from one section of the city to another must change cars and pay at least two fares. The report states that a similar "radial" arrangement of routes formerly prevailed in Detroit, but that through or "diameter" routes have recently been adopted as a means of economy in operation and increased accommodation to the public. Under this arrangement the cars start from the city limits, on one side, pass through the business section and continue to the city limits on the opposite side. In Detroit, too, tickets and transfers are good on the cars of different companies. It seems very certain that in a city as large as Chicago, better facilities should be afforded in this respect, as well as in the number of cars on some of the principal routes. In some cases single cars only are run, even in the busiest hours when they are crowded to the great discomfort and even danger of the passengers. The danger is especially great with the open cars having foot boards. On other lines of the same system trail cars are put on during these hours.

Another point which may be considered in this connection, but which is not referred to in the report, is the frequent use of open cars in cold, wet and wintry weather. In view of the very changeable and uncertain climate of Chicago, an ordinance should be adopted and enforced, requiring the companies to run a certain proportion of closed cars throughout the year, as is done in some eastern cities. The companies usually have two sets of equipment, and keep one in use and the other on storage tracks until the weather makes it absolutely necessary to change the sets.

As already noted, the companies cannot be expected to take the initiative in these improvements, although it might be good policy and even economy for them to do so. The city, however, has the remedy in its own hands, but in Chicago the ordinances for such purposes are usually so drawn that the companies successfully fight them in the courts. Even when such ordinances are allowed to stand, only spasmodic efforts are made to enforce them, and consequently the companies pay no attention to them unless disposed to do so. The use of fenders is a case in point. For a long time the city has tried to get the companies to equip their cars with fenders, but ordinance after ordinance has been turned down by the courts. One of these required "all cars" to be equipped, but the companies argued that this would include trail cars, which could not and need not be so equipped. The companies claimed that the fenders would be an absolute danger, and that the stop planks across the wheels were sufficient safeguards, in spite of the fact that investigations have shown their claim to be unsupportable. Fenders are now, however, beginning to be applied to the cars on some lines.

An ordinance was passed last year requiring the motor cars and grip cars to be equipped with vestibules or shelters for the men, and there were threats of vigorous enforcement. No attention was paid to the ordinance, however, and no practical results ensued, but throughout the severe winter the men worked exposed to the weather as usual, except on some few lines which ordinarily use vestibule cars.

To return to the committee report. The next subject taken up is that relating to wages of employees and conditions of employment, on which points very little official information was obtained. The gripmen and conductors on the cable lines appear to be ranked above the motormen and conductors on electric lines, the former receiving from 25 to 28 and 30 cts. per hour for a 10-hour day, while the latter receive 21 cts. per hour and work from 10 to 11 hours. If the cable lines should adopt the trolley system, as has been suggested, the lower rates of wages would prevail. It is commonly understood to be the policy of the companies to discourage and prevent any trade organization on the part of their men, and they are said to require these men to sign contracts not to join any labor organizations, though no copies of such contracts are given to the men or made public.

One rather important matter mentioned is the existence of many sections of tracks and junction curves which are disused. These are especially numerous in the business center of the city, and there are also two or three lines which are operated in a desultory way, merely to hold the right of way, and are of no use to the public. These tracks constitute a serious obstacle in the streets, especially in the case of curves at street intersections. While none of the ordinances for street railway grants contain specific provisions requiring the companies to operate the lines or entailing the forfeiture of the lines if not operated, yet it is held that the acceptance of the grants implies an obligation to operate the lines. The committee is of opinion that the city has the right to remove these tracks and to regard the lines as forfeited.

No reference is made in the report to the condition of the tracks and pavements, nor to the requirements as to paving, repairing and cleaning the streets, or removing snow therefrom. In all these respects the companies are very negligent, and they are frequently the source of trouble between the companies and the city. This class of investigation, however, was not included in the instructions to the committee, but from an interesting digest of laws and city ordinances affecting the rights of the street railways, which is appended to the report, we take the following:

(1883). Companies to repair and maintain 8 ft. and 16 ft. of streets then occupied.

(1887). When companies remove snow from their tracks, they must within reasonable time clear this from the cross walks and level it down along the roadway.

(1893). It shall be unlawful for the companies to sweep the snow from the center of the streets and allow it to remain, preventing access to the stores and dwellings along the route.

In conclusion we give a table, compiled from the voluminous figures and tables in the report, giving some of the most important and interesting items bearing upon the discussion of the relations of the street railways to the city. The figures given are brought down to Dec. 31, 1897:

Statistics of Operation of Chicago Street Railways.

		Chicago City Ry.	No. Chi. St.Ry.	W. Chi. St. Ry.
Stockholders' investment*		$12,000,000	$5,000,000	$12,439,000
Market value of stock		27,525,000	17,676,750	21,379,945
Profits to stockholders by appreciation of stock		15,525,000	12,676,750	8,940,945
Dividends†		6,956,645	4,419,704	3,253,240
Total profits in excess 8%		22,481,645	17,096,455	12,694,186
Per cent. gross receipts which could have been paid to city if dividends had been limited to 8%; 1890 to 1897		16.82	19.59	9.67
Reduced fare which might have been conceded, if as above, cts.		4.15	4.02	4.51
Lisense fees and amts for pub.impts. paid city, '97		$31,525	$35,359	$30,637
Value of present franchise	Equipment	21,628,180	18,071,420	22,854,610
	All trolley.	22,833,500	19,102,150	25,225,795
Cost, duplication§	Equipment	56,000	60,297	61,698
	All trolley.	50,000	50,000	50,000
Total cost, duplication	Equipment	10,316,320	6,035,927	12,506,184
	All trolley.	9,211,000	5,005,000	10,135,000
Total capitalization		16,619,500	14,780,900	31,857,900
Over capitalization	Equipment	6,303,186	8,745,170	19,351,715
	All trolley.	7,408,500	9,775,900	21,722,900
Mileage	Total (single tr'k)	184	100	202.70
	Cable	35	17	30.42
	Horse	7.5	2	6.60
	Trolley	141.5	81	165.58
Passengers carried, 1897		95,621,000	56,354,000	....
Gross receipts, 1897		$4,816,000	$2,836,000	$3,899,918
Ratio, op.exp. to grs rec. '90		66.85%	55.09%	60%
" " " " '97		60.40%	46.83%	50%

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*Face value of stock.

†Dividends in excess of 8% on face value, 1890-'97, with accumulation at 4% compound interest. Similar figures are given for a dividend of 6%, but these we do not think it necessary to reproduce.

§Per mile.

MINERAL PRODUCTS OF THE UNITED STATES IN 1897.

Mr. David T. Day, Chief of the Division of Mineral Resources, U. S. Geological Survey, has issued a tabular statement of the mineral products of the United States for each year from 1888 to 1897, inclusive. An abstract of the chief items follows; though this abstract is generally confined to the year 1897, with some comparisons with previous years:

The pig-iron output for 1897 was 9,652,680 tons, valued at $95,122,299. This is the largest output in tons in the decade under consideration; but the 9,202,703 tons of 1890 were valued at $151,200,410, indicating a marked decline in price per ton since that date. The gold and silver output last year was 2,774,935 ozs. of gold, valued at $57,363,000, and 53,860,000 ozs. of silver, valued at $69,637,172; generally speaking, there has been a decline in the silver production and a gain of nearly 40% in that of gold in the past decade. The copper output for 1897 exceeds that of any previous year, and has risen from 231,270,622 lbs. in 1888, valued at $33,833,954, to 491,638,000 lbs. in 1897, valued at $54,080,180. The lead produced in 1897 amounted to 208,192 tons, worth $14,885,728; this is also larger than for any other year in the decade, and has steadily increased from 151,919 tons in 1888, valued at $13,399,256, again showing a fall in price per pound. Of other metallic products in 1897, zinc shows 99,980 short tons, worth $8,498,300; quick silver, 26,648 flasks, worth $993,445; aluminum, 4,000,000 lbs., worth $1,500,000; this latter is an increase from 1,300,000 lbs. in 1896, 920,000 lbs. in 1895, and 19,000 lbs. in 1888. There were reported for last year 23,707 lbs. of nickel; no tin, and 150 lbs. of crude platinum.

The non-metallic products also generally show marked gains in 1897 over other years in the decade 1888-1897. Bituminous coal amounted to 147,789,902 short tons, worth $119,740,052, and the increase is practically steady from 102,039,838 short tons in 1888, valued at $101,860,529. Pennsylvania anthracite, however, fell, in 1897, to 46,814,074 long tons, worth $79,129,126, from a maximum output in 1895, for the decade, of 51,785,122 long tons, worth $82,019,272. The petroleum output last year was 60,568,081 barrels, worth $40,929,611, as compared with 60,960,361 barrels in 1896, valued at $58,518,709. Of cement, 10,989,463 barrels, worth $8,178,283, were made in 1897; this is greater than for any year in the decade. Other important non-metallic products were as follows, for 1897: Mineral waters, 23,255,911 gallons, worth $4,599,106; phosphate rock, 1,039,345 long tons, worth $2,673,202; 15,973,202 barrels salt, worth $4,920,020; 4,247,688 long tons limestone, for iron flux, worth $2,124,000; and 16,000,000 lbs. borax, worth $1,080,000.

The total values of the mineral products of the United States for 1897 sum up as follows: Non-metallic, $329,113,845; metallic, $302,198,502; unspecified, $1,000,000; grand total, $632,312,347. This is the maximum total for the decade 1888-1897; that for 1888 being $540,781,936, or $91,530,411 less in amount than for last year.

THE NEW PUBLIC ELECTRIC LIGHTING CONTRACT for Boston contains some novel features. It is for a period of ten years, from Feb. 20, 1899, and thereafter until a new agreement is made or either party notifies the other in writing of its decision to terminate the contract. The contract, however, is subject to the yearly appropriations of the city council. The prices are on a sliding scale, ranging from 35 cts. per lamp per night, or $127.75 per year, for 2,365 lamps, to 30 cts., or $109.50, each, for 5,000 lamps. The price must be readjusted by arbitration at the end of five years, and may be so readjusted at the end of 2½ and 7½ years, if the Mayor so elects, as to keep the net earnings down to 6% on the capitalization devoted to public business, or at a correspondingly lower rate in case any of the bonds bear less than 6% interest. The distribution of the expenses and earnings between public and private lighting is to be based on the relative electrical outputs, measured separately in kilowatt hours, for each class of business. A maximum depreciation of 7%, exclusive of land, is to be allowed in calculating the net earnings. The city may also refer to its arbitrators any invention or improvement which it claims will reduce the cost of electric lighting. If the arbitrators report that the claims of the city are valid, the price for public lighting is to be decreased accordingly, whether the company adopts the improvement or not. The company is to substitute, at its own expense, wooden poles, with ornamental iron goose-neck lamp supports, for the iron posts now owned by the city. It is also to provide closed arc lamps, like those described in U. S. Patent No. 603,630, dated May 10, 1898, for the open lamps now in use. The new lamps are to require an electrical energy of not less than 500 watts on the average and not less than 480 in any case. The present lamps have a nominal candle power of 2,000. This contract is a modification and continuation of the five-year contract made in 1894. Its new features are largely due, we judge, to Mr. Josiah Quincy, Mayor of Boston, who recently gave it his approval.

WEATHER TABLE FOR SEPTEMBER, 1898. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.)				Wind.			Precipitation—Rain or melted snow. (Inches.)		
						Velocity in miles per hour.		Direction at time of max. velocity.			
		Average.	Max.	Min.	Range.	Average.	Max.		Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	59.0	90	30	60	7.7	42	SW	2.66	1.01	[illegible]
	Portland, Me.	61.2	87	41	46	6.1	30	NW	3.48	1.38	11
	New York City	68.9	94	49	45	10.2	72	SW	1 28	0.94	6
	Pittsburg, Pa.	70.2	94	48	46	5.3	24	N	1.06	0.42	8
	Chicago, Ill.	67.6	92	49	43	15.9	41	E	3 16	1.20	11
	Omaha, Neb.	68.3	96	43	53	7.4	30	S	2.94	1.42	6
	St. Paul, Minn.	63.4	95	38	57	6.8	32	SE	0.90	0 46	6
	Duluth, Minn.	59.2	86	40	46	10.0	34	SW	1.21	0.43	10
	Bismarck, N. Dak.	58.6	97	28	69	9.1	50	NW	0.76	0.32	5
	Average	64.1	92	41	52	8.7	39	—	1.94	0.84	8
Southern Cities.	Washington, D. C.	71.0	95	48	47	5.0	30	NW	0.89	0.69	5
	Louisville, Ky.	73.8	97	52	45	6.8	48	W	2.97	1.36	9
	St. Louis, Mo.	74.2	95	51	44	9.2	30	SW	3.23	0.85	12
	Savannah, Ga	78.0	91	64	27	7.8	25	S	5.06	1.91	10
	Kansas City, Mo.	71.4	94	48	46	8.1	31	SE	4.48	1.73	10
	Jacksonville, Fla	79.8	93	69	24	7.6	28	SE	3 46	1.28	13
	Chattanooga, Tenn.	73.6	90	57	33	5.2	27	SW	6.50	4.30	6
	New Orleans, La.	79.5	92	68	24	8.2	42	SE	13.90	2.99	18
	Memphis, Tenn.	76.2	93	57	36	9.4	34	E	5.57	2.57	9
	Palestine, Tex.	77.8	95	55	40	5.8	18	SW	1.92	0.70	7
	Average	75 4	94	57	37	7.3	31	—	4.80	1.84	10
Western Cities.	Helena, Mont	56.7	87	32	55	7.5	32	SW	0.87	0.35	8
	Port Angeles, Wash.	55.0	76	38	38	4.9	30	NW	1.78	1.01	9
	San Francisco, Cal.	58.9	80	50	30	11.9	35	W	1.06	0.73	3
	Salt Lake City, Utah.	65.6	90	36	54	6.2	33	S	0.15	0.13	3
	Santa Fe, N. Mex.	61.1	82	32	50	5.4	30	S	0.18	0.12	2
	Denver, Colo.	61.9	90	32	58	7.7	41	S	0.28	0.13	6
	Yuma, Ariz.	—	—	—	—	—	—	—	—	—	—
	Average	59.9	84	37	48	7.3	34	—	0.72	0.41	5

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Street cleaning and garbage collection in Chicago are being now more than usually neglected, the money appropriated and the time of the men employed having been apparently largely diverted to political campaign purposes. Chicago is notorious for its ill-paved and dirty streets, and in fact it has hardly a street in good condition, with the exception of the boulevards (which are cared for by the Park Commissions and not by the city authorities), and some suburban roads. Many of the important business thoroughfares have great holes and pools of mud, which it would be impossible to clean in any ordinary way, even if the attempt were made. Such repair work as is done is largely of a very poor quality, and in some cases the property-owners have preferred to do the work by private contract, under permission from the city. All municipal work is under political rule, in spite of efforts to introduce the civil service system. Only recently, a man who had the work of street cleaning in one of the wards, but who had not a regular contract (being paid by the day), was replaced by another man without any notice, because he had interfered in some way with the aims of a local politician. The new man, having no proper machinery, made a failure of the work. To one who has seen the streets of Detroit, Milwaukee, Denver, San Francisco, or even Kansas City, the Chicago streets appear to be deplorably bad and filthy. After the litigation over the garbage collection contracts, which has been recorded in our columns, the city took up the work, and the authorities talked loudly about the great improvements that were to be made. At the present time, however, the garbage boxes are overflowing with the accumulation of weeks, and dirt, refuse and waste paper are thick in the alleys. In some of the residence districts the garbage wagons come along at irregular intervals of two to four weeks. Recently, the complaints have been so numerous that the authorities have taken steps to have this matter attended to, for fear of their political opponents making capital out of it during the coming campaign, and they have also promised to clean the streets on the route of the jubilee parade. The Council has made an appropriation of $50,000 for the work, but this has been declared illegal, as the city, under the terms of its charter, exhausted its power in this direction last spring, when it made an appropriation for the same purpose, and which has long since been expended. Even if the appropriation should hold, the local papers express the opinion that it would not result in $50,000 worth of street cleaning. After a few weeks, the present condition of affairs will doubtless prevail again. Many of the bridges, and viaducts also, are in very bad condition, owing to failure to provide money for painting or repair. The city of Chicago is loud in proclaiming preeminence among western cities, but it is more noted for a certain bad eminence as an example of defective municipal government under political administration on the "spoils" system.

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For a long time, builders and users of steam engines have felt the need of some better method of measuring and recording the power developed by a steam engine than the ordinary piston indicator. The desirability of this has been more than ever felt since electrical machinery came into general use, and its advantages in the way of accurate indicating and recording instruments became familiar to mechanical engineers. The electrical engineer, although the industry with which he is concerned is not a score of years old, has at his disposal instruments which show him at a glance the amount of power which his machines are giving out or absorbing. The steam engineer who desires to know the power his engine is developing must perform the tedious work of taking an indicator card, measuring and computing it, and when his task is done he knows only the power developed at a given instant, which in an engine with a variable load may vary widely from the average work that the engine is doing.

The task of doing for the steam engine what the wattmeter does for the electric motor, has been attacked within recent years by a number of inventors. The devices they have produced, however, have generally been based upon the ordinary steam cylinder indicator invented by James Watt, and first employed by him in experimenting with his engines. Taking this as a foundation, other inventors have devised various types of continuous recording instruments which it may be interesting to briefly review.

In the simplest of these the oscillating drum of the ordinary indicator is replaced by an arrangement which feeds a continuous ribbon of paper. An example of this class was described by its inventor, Prof. Thomas Gray, at the meeting of the American Society of Mechanical Engineers, in May, 1897 (Eng. News, June 3, 1897). The record of this instrument is a continuous zigzag line or wavy line, the amplitude of the waves giving the indicated pressure and their length, the length of stroke.

A step in advance of the instrument just described is to make an instrument in which a mechanical integration of the continuous diagram is effected. One of the best of this class of instruments is that devised by Mr. W. O. Amsler, of Pittsburg, and described in the "Sibley Journal of Engineering," for October, 1896, and later by Mr. A. A. Cary.* In this instrument the inventor still adheres to the piston and spring, although the spring is not in direct contact with the steam. With this instrument steam is admitted to both sides of the piston, which moves up and down under the combined influence of the steam from the engine cylinder and the indicator spring. In so doing it shifts the center of a spherical roller which is in contact with a small cylinder whose axis is parallel with the piston motion. This spherical roller is being continually oscillated about its axis by a reducing motion similar to that used with the ordinary indicator. With atmospheric pressure in the engine cylinder the axis of the spherical roller is perpendicular to the rolling cylinder, and no motion results. Increase the pressure and the axis of the spherical roller tips, throwing the point of contact out of line with its axis and immediately the cylinder begins to turn. In turning (which it will do to an amount proportional to the inclination of the axis of the spherical roller and the rate of rotation of the latter which depends upon the position of the engine piston), it drives a small dial at one end of the cylinder, which always turns in one direction. It will be seen that the instrument can be so calibrated as to continuously indicate the power developed.

Another example of this class of instrument was described in Engineering News, July 28, 1898. It is the invention of Messrs. W. G. and C. W. G. Little, Bexley, Kent, England, and as in the other cases depends upon the small steam cylinder, piston and spring. The paper drum is replaced by a plain metallic drum upon which rolls a small integrating wheel, the inclination of whose plane of rotation is varied by the indicator piston. In other words, this integrating wheel replaces the pencil motion of the ordinary indicator.

There is also a modification of this form designed by Prof. C. S. Brown, and described by Prof. Thomas Gray, in the Transactions Am. Soc. M. E. (Vol. XVIII., p. 1,035), in which the drum, instead of oscillating, is given a reciprocating motion back and forth along the line of its axis by a reducing motion. The wheel or roller presses against its surface, and as its plane is shifted by the movement of the piston, just as in the Little instrument, the cylinder is turned. The force with which the cylinder revolves is considerable, and is used to drive a light train of gears turning needles over properly-calibrated dials.

◆

This steam engine power gage is a wide departure from the other instruments above described. The ordinary steam engine indicator preserves the cylinder and piston which are the essential parts of the engine itself. The new power indicator discards these and adopts in their place the steam turbine. Briefly stated, the power measuring part of the device consists of a small steam turbine operated by two jets of steam, one from the working end of the cylinder and one from the exhaust, arranged to oppose each other so that the actual turning force at any instant is proportional to the effective cylinder pressure, and the greater the pressure the greater the speed of the turbine. This turbine, which has sufficient weight and inertia to maintain its speed between the impulses which occur, owing to the reversal of piston direction and the changing of pressures from one end of the cylinder to the other.

It may be asked whether the speed of the turbine is directly proportional to the pressure of the steam issuing from the cylinder. If the turbine were entirely free to revolve, this probably would not be the case, since the velocity of the steam issuing from a nozzle increases very slowly with increase of pressure after about 10 lbs. gage pressure is reached. However, as the turbine is given a load which causes it to revolve much more slowly than the steam, its speed will be proportioned not to the velocity of the steam, but to the energy of the issuing steam jet, and this is approximately proportional to the steam pressure.

We think our readers who follow the detailed description of the power gage in another column will be satisfied that the instrument is designed upon correct principles. It may seem to them, however, that it would be impossible for an instrument of this sort to be accurate in its indications. The only proof of this, of course, is actual test; and we are informed that the tests thus far made have shown gratifying results.

The practical value of an instrument which will indicate upon a dial at every moment the horsepower which an engine is developing is too obvious to require proof. It will doubtless be an easy step from such an instrument to an automatic recording instrument which will tell a graphic story at a glance to the eye of the Manager or Superintendent.

◆

Gen. Henry L. Abbot, Corps of Engineers, U. S. A., and member of the technical commission on the Panama Canal, asks us to correct several errors in the original manuscript of his article printed in this journal Oct. 6. The errors are important and for this reason we call attention to them in this place. Under the heading of the "Regulation of the Chagres River," in the second paragraph, the sentence, commencing "the largest within the memory of the inhabitants," should read, "is at Gamboa, 2,040 cu. m. per second," in

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*Transactions Am. Soc. M. E., Vol. XVIII., p. 1026.

PROGRESS VIEWS OF THE NEW CROTON DAM.

Alphonse Fteley, Pres. Am. Soc. C. E., Chief Engineer.

Coleman, Breauchaud & Coleman, Contractors.

Chas. S. Gowen, M. Am. Soc. C. E., Resident Engineer.

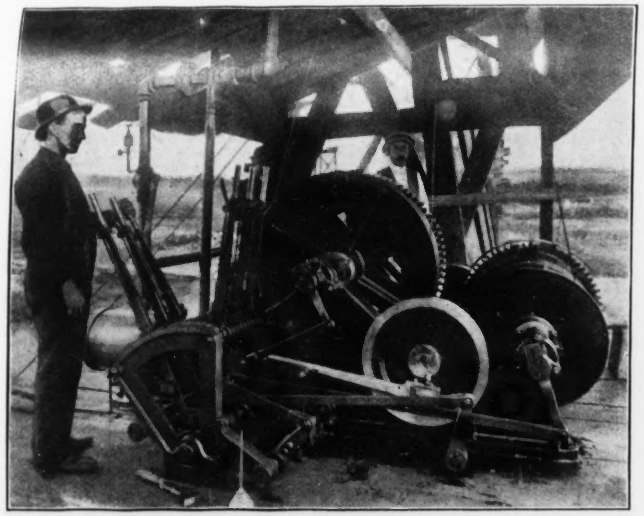

FIG. 2. ENGINE FOR OPERATING SHERMAN HOISTING AND DISTRIBUTING PLANT. W. D. SHERMAN, INVENTOR OF PLANT.

FIG. 1. CONCRETE FLOOR OF SEDIMENTATION BASIN, WITH ONE TRESTLE OF HOISTING AND DISTRIBUTING PLANT IN THE BACKGROUND.

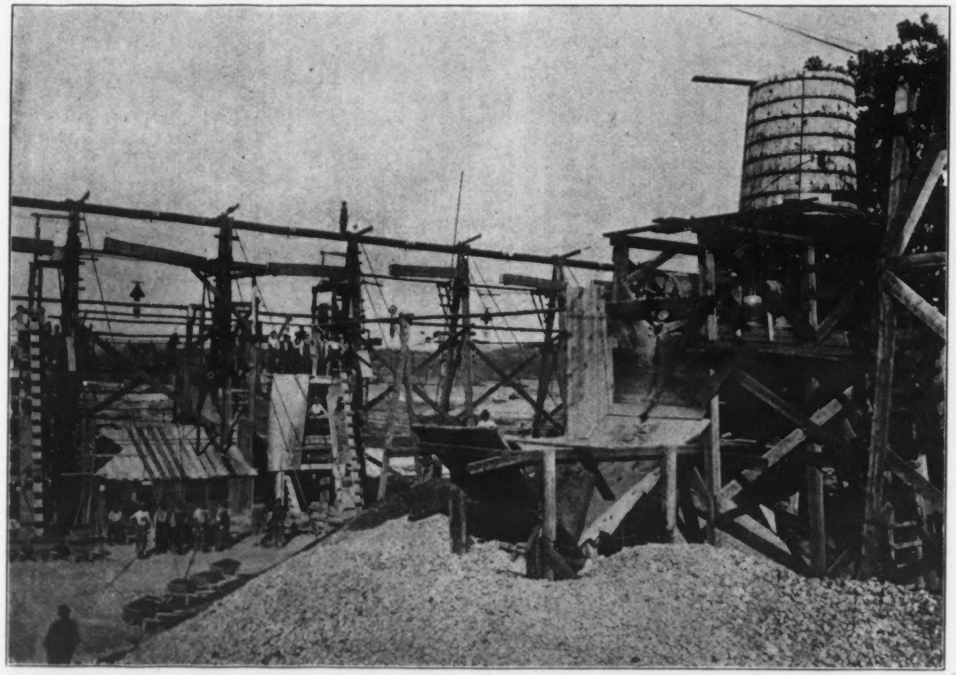

FIG. 3. SCREENING APPARATUS, CONCRETE MIXERS AND TRESTLE FOR DISTRIBUTING PLANT.

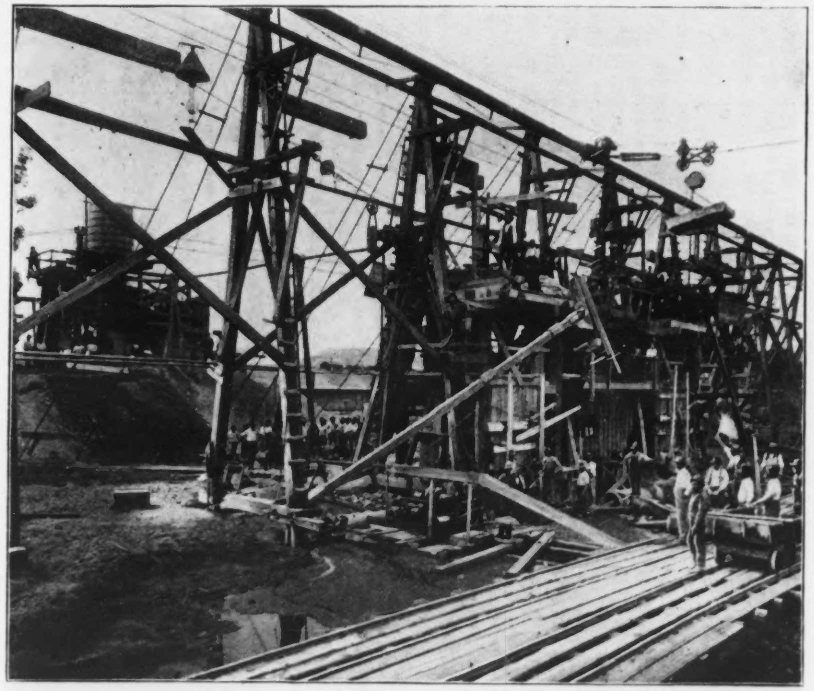

FIG. 4. CONCRETE MIXERS, TRESTLE FOR DISTRIBUTING PLANT, AND CROSS-CARRIER TRACKS.

VIEWS OF THE WATER PURIFICATION PLANT UNDER CONSTRUCTION AT ALBANY, N. Y.

Allen Hazen, Assoc. M. Am. Soc. C. E., Chief Engineer.

Wilson & Baillie Mfg. Co., Contractors.

FIG. 2. LOOKING SOUTHEAST, FEB. 7, 1896. NEW RIVER CHANNEL IN FLOOD, WITH EXCAVATION IN PROGRESS BEYOND.

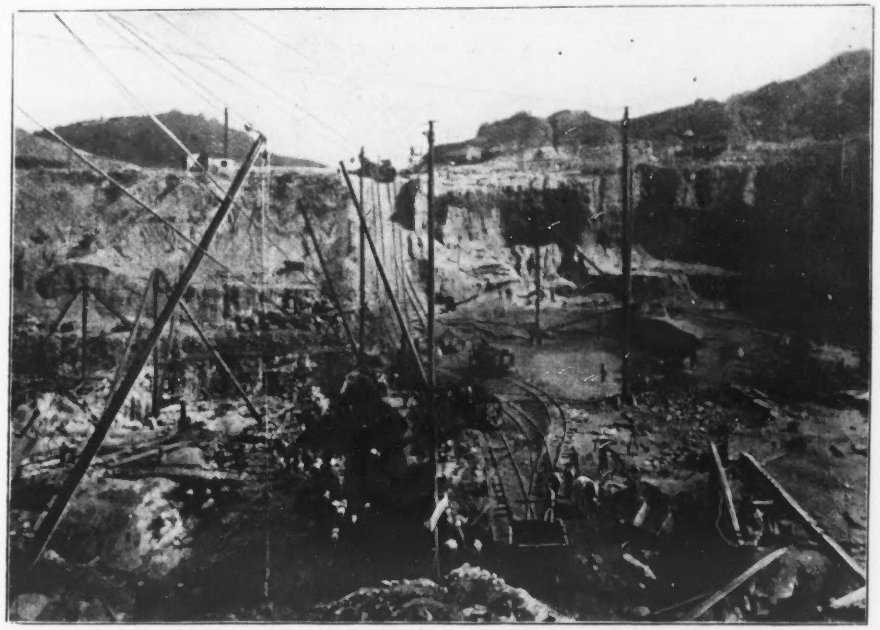

FIG. 3. LOOKING EAST, SEPT. 30, 1896. EXCAVATION AS SEEN FROM FOOT OF INCLINE RAILWAY, No. 3.

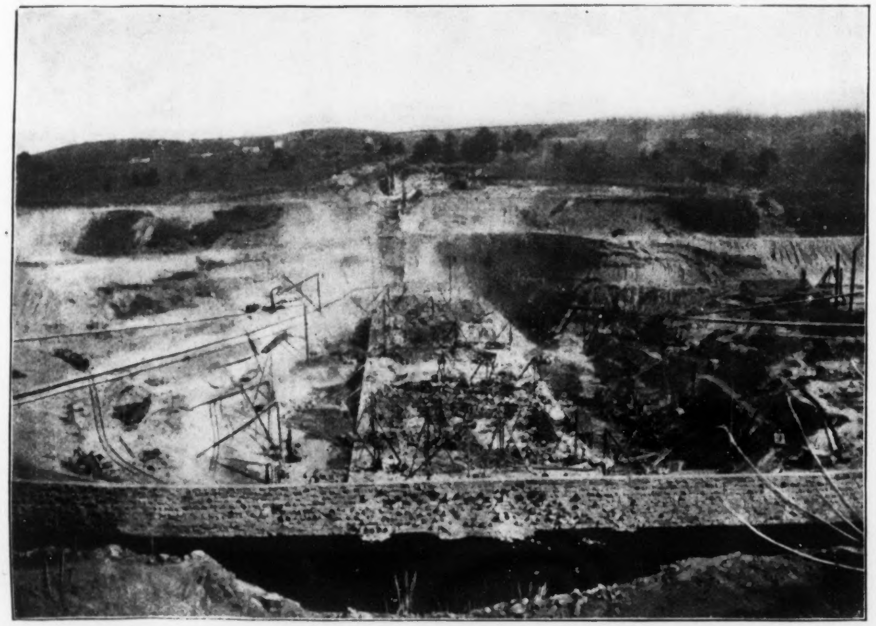

FIG. 4. LOOKING SOUTH ACROSS MAIN DAM, APRIL 13, 1898. NEW RIVER CHANNEL IN FOREGROUND.

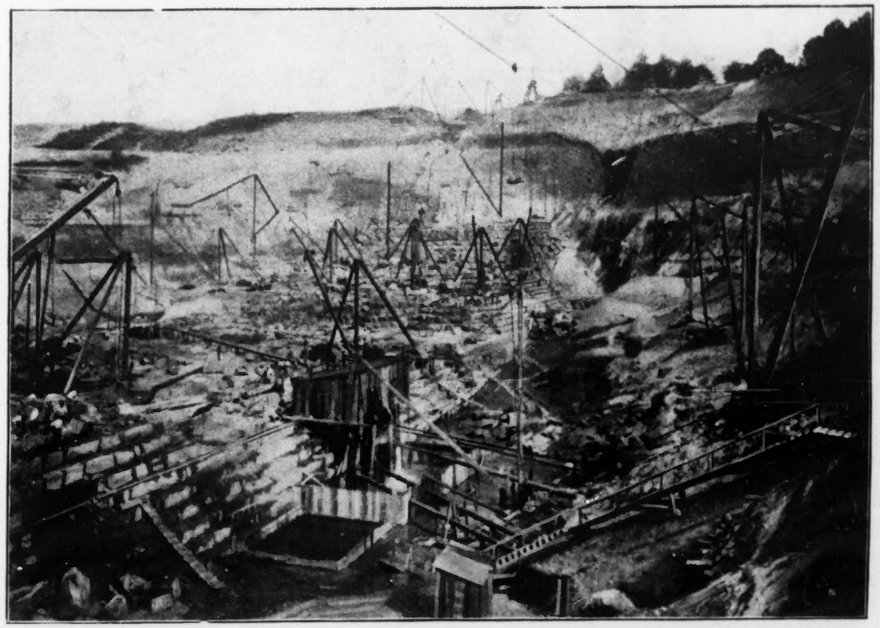

FIG. 5. DOWN-STREAM SIDE, JUNE 6, 1898. EXCAVATION FOR FARTHER END OF HEART-WALL OF SOUTH EMBANKMENT IN THE DISTANCE.

PROGRESS VIEWS OF THE NEW CROTON DAM.

Alphonse Fteley, Pres. Am. Soc. C. E., Chief Engineer.

Chas. S. Gowen, M. Am. Soc. C. E., Resident Engineer.

Coleman, Breauchaud & Coleman, Contractors.

stead of 1,630 cu. m. In the next paragraph, the sentence, "reservoirs to contains 1 million cu. m., above Alhajuela and 1.5 million cu. m. above Bohio," should be corrected to 100 million cu. m. above Alhajuela, and 150 millions cu. m. above Bohio." In the sixth paragraph, the sentence "calling for a layer of water 9 m. deep, to contain 1 million cu. m.," should read "100 million cu. m." In the eighth paragraph, the sentence "a capacity of 1.5 million cu. m.," should read "150 million cu. m."

LOSSES OF HEAT IN A STEAM PLANT.

The science of thermodynamics is taught, and we presume well taught as a rule, in all our schools of mechanical engineering, and its elements at least are more or less familiar to all engineers engaged in steam engineering work. And yet we venture to say that there are few among either students or practitioners who will not obtain, if they study the accompanying diagram, a clearer idea of the heat losses and heat interchanges that take place in a working steam plant than they have ever had before.

It is a fact too often forgotten by teachers—and let us add, by those who write for and edit technical journals, as well—that it is the fact presented in the simplest and most forcible form that sticks in the mind. For example, the literature of steam engineering contains much with reference to the losses that take place during the expansion of steam in an engine cylinder. They have been explained and presented in diagrams and equations galore, yet an engineer of thorough education and wide acquaintance with the literature of steam engineering tells us that this never became a vivid, concrete reality to his mind until he ran across the statement that the difference in the temperature of steam in an ordinary engine when it entered the boiler, and when the exhaust port was opened was greater that the difference between the hottest day of summer and the coldest day of winter.

It is the trouble with much of our teaching and much of our learning, too, that we fail on the one hand to present facts, and on the other hand to grasp them in a way that shall make them vital realities to the mind. It is one of the objections to advanced mathematical work for engineering students, that it diverts the mind from realities to abstract things. The student absorbed in algebraic manipulations too often forgets what his symbols represent, and thereby falls into errors of reasoning which make his whole work of no value.

Turning again to the diagram shown herewith, it seems to us that it presents more vividly and clearly to the mind the heat interchanges of a steam power plant than anything which we have ever seen in technical literature. The broad river of heat generated by the coal burned on the grate is shown flowing to and through every part of the apparatus, losing by radiation at every step, and finally emerging at the chimney in a flow of heated air and gases, at the condenser in the circulating water discharged and at the engine shaft as useful work.

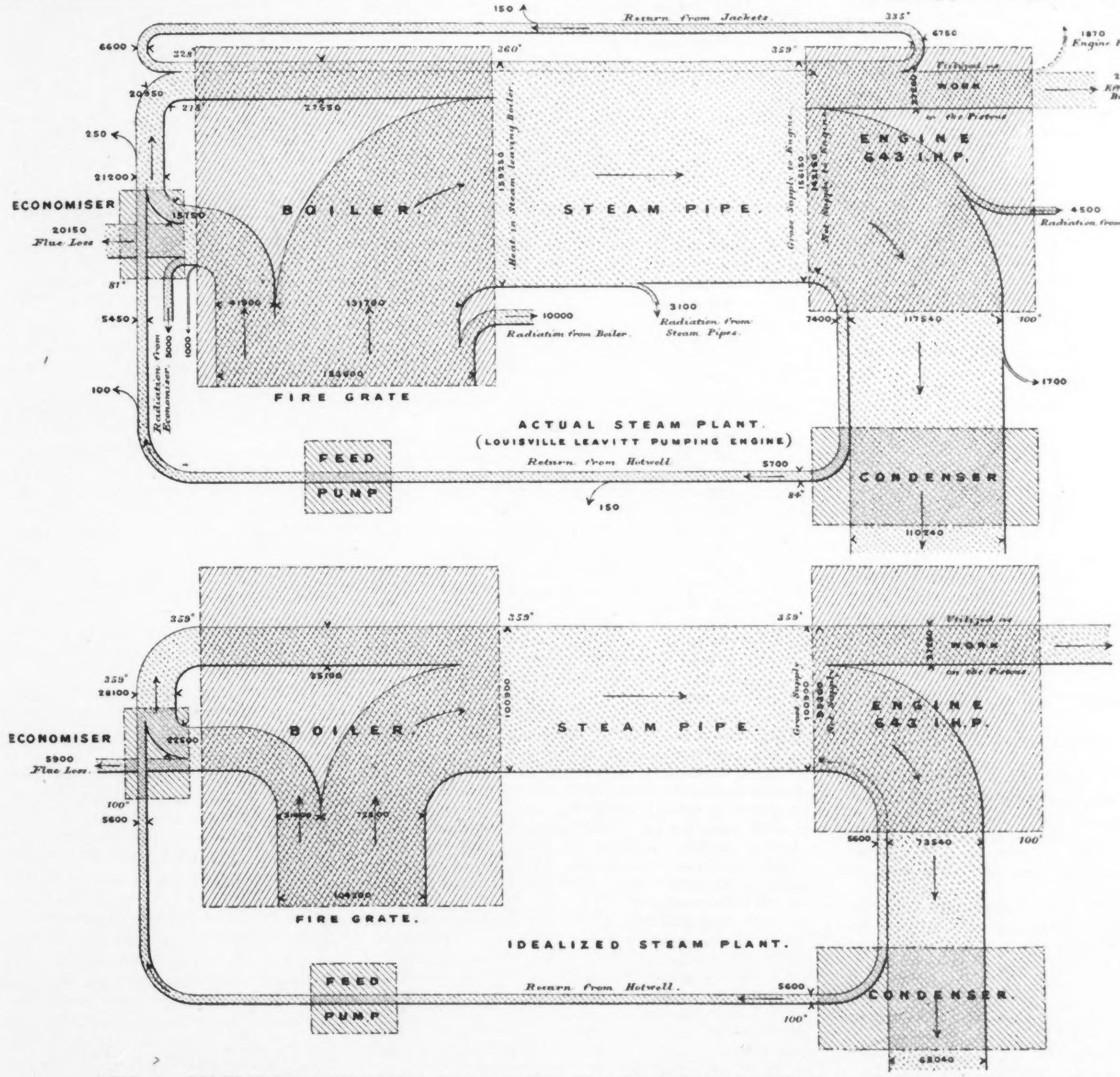

FIG. 1.—DIAGRAMS ILLUSTRATING THE LOSSES AND TRANSFERS OF HEAT IN STEAM POWER PLANTS.

We have reproduced this diagram from the report recently issued by a committee of the Institution of Civil Engineers upon the "Thermal Efficiency of Steam Engines," made up by Professors Kennedy, Macfarlane, Gray, Ewing and Beare, Capt. H. R. Sankey and Messrs. Capper, Davey, Donkin, Longridge and Maw. The diagram shown herewith was made by Capt. Sankey, to accompany an introduction to the report, and to make clear exactly what is meant by the "thermal efficiency" of a steam engine.

The boiler, the engine, the condenser and the air pump; the feed-pump and economizer, are each shown on the diagram by rectangles (of arbitrary size). The flow of heat is shown as a stream, the width of which is proportional to the amount of heat entering and leaving each part of the plant per unit of time. The losses are shown by the many waste branches of the stream. Capt. Sankey continues the description of the diagram as follows:

> The upper diagram represents, in the main, the trial of the Louisville Leavitt pumping engine as described in the Transactions of the American Society of Mechanical Engineers, Vol. XVI.,* and the data are sufficiently full to enable the flow of heat to be stated at all points with fair accuracy. The numerals represent British thermal units flowing per minute; the streams are drawn to such a scale that each inch of width represents a flow of 100,000 B. T. U. per minute. Temperatures are also given.
>
> Starting at the fire-grate, it is shown that 183,600 B. T. U. are produced per minute by the combustion of the coal, and that 131,700 of these go direct into the water of the boiler, 10,000 are lost by boiler radiation and leakage, and the remainder, viz., 41,900, pass away with the flue gases. On the way to the economizer, 1,000 B. T. U. are lost by radiation, but in the economizer itself 15,750 B. T. U. are diverted into the feed water, 5,000 B. T. U. are dissipated by radiation, and finally 20,150 B. T. U. pass out of the economizer and into the chimney, and are lost to the steam plant. The heat entering the economizer with the feed-water is 5,450 B. T. U., which is added to the 15,750 B. T. U. diverted from the flue gases, thus giving a flow of 21,200 B. T. U. in the feed out of the economizer. Radiation, however, reduces this flow to 20,950 B. T. U. per minute at the entry to the boiler, where a further

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*Eng. News, Dec. 13, 1894.

addition is made of 6,600 B. T. U. returned by the jacket water.

The steam produced by the boiler is thus seen to derive its heat from three streams, as shown on the diagram; the steam finally leaves the boiler with 159,250 B. T. U. per minute. Before this heat gets to the engine, however, 3,100 B. T. U. are lost by radiation and leakage from the steam pipes, so that the flow of heat is reduced to 156,150 B. T. U. per minute, which is the gross supply of heat to the engine; the net supply is less, because there are certain returns of heat to the boiler to be deducted. In the first place credit has to be given to the engine for the heat which could be imparted by means of the exhaust steam to the feed-water, inasmuch as the exhaust is theoretically, and very nearly practically, capable of raising the temperature of the feed to the exhaust temperature. On this basis, 7,400 B. T. U. should be credited to the engine, although the actual return to the boiler, or rather to the economizer, is only 5,450 B. T. U. The difference is due to excess of circulating water, which lowers the hot-well temperature, and also to radiation in the feed arrangements, which are a necessary portion of the steam plant, independent of the engine proper, and which are not applied to correct any fault of the engine. The loss of 1,950 B. T. U. should therefore be debited to the feed and condensing arrangements, and not to the engine. It will be seen that the 7,400 B. T. U. credited to the engine is equal to the water-heat of the feed at the temperature of the exhaust. In the present case a special credit has to be given to the engine, because 6,750 B. T. U. leave the engine in the jacket water to return to the boiler; but 150 are lost by radiation on the way, so that the net return is 6,600 B. T. U. Only the net return to the boiler should be credited to the engine, because the jackets are applied to correct a fault of the engine, namely, cylinder condensation; hence any loss to the steam plant that may be entailed by the use of jackets (i. e., the radiation in question) should be reckoned as a loss due to the engine, although it takes place outside the engine. In the case under consideration the jacket water was returned direct to the boiler; but if, as is frequently the case, the jacket water is drained into the hot-well, the heat in it cannot be credited to the engine, for the reasons given above.

The net supply to the engine can therefore be obtained as follows:

	B. T. U.	B. T. U.
Gross supply	....	156,150
Less returnable by feed	7,400	....
" returned by jackets	6,600	....
		14,000
Net supply per minute		142,150

It will be seen that only 27,260 B. T. U. are utilized as work upon the pistons. The ratio of the heat so utilized to the net heat supplied is called in this report the "Thermal Efficiency of the Engine." In the numerical case under consideration the thermal efficiency is $\frac{27,260}{142,150} =$ 0.15.

The engine under discussion indicates 643 HP.; the heat supplied "per minute per I. HP." is therefore $\frac{142,150}{643}$ = 221 B. T. U., and it is this figure which, as recommended in the report, should be used to express the thermal economical value of a steam engine. This recommendation is made with a view of replacing the present usual method of stating the performance in lbs. of feed-water per I. HP. per hour, although the latter statement is useful for other purposes.

It will be seen that 1,870 B. T. U. are deducted from the 27,260 utilized as work on the pistons, as engine friction, so that the effective or brake power of the engine corresponds to 25,390 B. T. U. per minute; in other words, the brake HP. of the engine is 599, so that the "B. T. U. per minute per I. HP." are $\frac{142,150}{599} = 237$, another figure which the committee recommends should be quoted whenever it is possible to ascertain the brake efficiency.

Let it now be supposed that the actual steam engine is replaced by an ideal steam engine, forming part of an idealized steam plant working according to the "Rankine cycle," using for this cycle the name recommended by the committee. It must be assumed that the I. HP. of the "ideal" engine is the same as that of the "actual" engine, namely, 643 HP., and that the admission and exhaust temperature are the same, namely, 359° F. and 100° F. respectively. The flow of heat in the ideal steam plant is represented by the lower diagram, and it will be observed that all the losses have disappeared, except the flue loss and the heat carried away by the condensing water. There are no jackets, but there is an economizer, because, although the boiler is perfect, 31,400 B. T. U. are sent into the flue, since the gases cannot be cooled down below the temperature of the water in the boiler, and a portion of this heat can be saved by heating the feed to the steam temperature. The heat returnable by the feed is, of course, less than in the case of the actual engine, owing to the reduced weight of steam passing through the engine. The heat supplied to the ideal engine is therefore:

	B. T. U.
Gross supply	100,900
Less returned by feed	5,600
Net heat supplied per minute	93,300

The I. HP. of the ideal steam engine being the same as that of the actual engine, the same number of B. T. U. per minute are utilized as work upon the piston, namely, 27,260. The thermal efficiency of this ideal steam engine is therefore $\frac{27,260}{95,300} = 0.285$, and the B. T. U. per minute per I. HP. are $\frac{95,300}{643} = 148$, as against 221 for the actual engine. The actual engine, therefore, requires 73 B. T. U. per minute per I. HP. more than the ideal engine; these heat-units are lost on account of imperfections in the actual engine, and can be looked upon as a measure of these imperfections. The ideal steam engine thus becomes the "standard of comparison," as recommended and defined by the committee.

The number of B. T. U. per minute per I. HP. required by the ideal engine depends on the temperature of the steam at admission, and its temperature at exhaust, and also on whether the steam is saturated or superheated. Fig. 2 has been drawn to enable this number of B. T. U.'s to be read off directly in all cases likely to occur in practice.

If the number of B. T. U. per minute per I. HP. required by the ideal engine be divided by the number needed by the actual engine, there is obtained what has been called the "efficiency ratio" by the comimittee. In the numerical case under consideration this ratio is $\frac{148}{221} = 0.67$.

The report of the committee, to which the above forms an introduction, is too long for us to reprint. Their recommendations, however, are summarized as follows:

1. That "thermal efficiency" as applied to any heat engine should mean the ratio between the heat utilized as work on the piston by that engine and the heat supplied to it.

2. That the heat utilized as work be obtained by measuring the indicator diagrams in the usual way.

3. That in the case of a steam engine, the heat supplied be calculated as the total heat of the steam entering the engine less the water-heat of the same weight of water at the temperature of the engine exhaust, both quantities being reckoned from 32° F.

4. That the temperature and pressure limits, both for saturated and superheated steam, be as follows:

Upper limit: the temperature and pressure close to, but on the boiler side of, the engine stop-valve, except for the purpose of calculating the standard of comparison in cases when the stop-valve is purposely used for reducing the pressure. In such cases the temperature of the steam at the reduced pressure shall be substituted. In the case of saturated steam the temperature corresponding to the pressure can be taken.

Lower limit: the temperature in the exhaust-pipe close to, but outside, the engine. The temperature corresponding to the pressure of the exhaust steam can be taken.

5. That a standard steam engine of comparison be adopted, and that it be the ideal steam engine working on the Rankine cycle between the same temperature and pressure limits as the actual engine to be compared.

6. That the ratio between the thermal efficiency of an actual engine and the thermal efficiency of the corresponding standard steam engine of comparison be called the "efficiency ratio."

7. That it is desirable to state the thermal economy of a steam engine in terms of the thermal units required per minute per I HP., and that, when possible, the thermal units required per minute per brake HP. be also stated.

8. That, for scientific purposes, there be also stated the thermal units required per minute per HP. by the standard engine of comparison, which can readily be obtained from a diagram similar to that given in Fig. 2, and from which the efficiency ratio can be deduced.

Your committee would also suggest that in papers submitted to the institution bearing on steam-engine economy, authors be invited to conform to the above recommendations.

The only matters in the above recommendations which may need further explanation relate to what the committee defines as the "standard steam engine of comparison," and which is designated on the diagram as an ideal steam engine. The description given of this engine in the report is as follows:

After careful consideration, your committee recommend an ideal steam engine working as part of the Rankine cycle as the standard steam engine of comparison, both for saturated and for superheated steam engines.

The definition of the Rankine cycle is as follows: It is assumed that all the component parts of the steam plant are perfect, and that there are no losses due to initial condensation, leakage, radiation, or conduction, and that there is no clearance in the cylinder. The feed-water required is taken into the boiler at the exhaust temperature, and its temperature is gradually raised until that corresponding to saturated steam is reached. Steam is then formed at constant pressure until dry saturated steam is produced, after which, if the steam is to be superheated, heat is added at constant pressure and at increasing temperature, until the required temperature of superheat is reached. The steam is introduced into the cylinder at constant pressure, displacing the piston, and performing external work equal to the absolute pressure multiplied by the volume swept through by the piston up to the point of cut-off. Beyond that point expansion takes place adiabatically, doing work until the pressure in the cylinder is equal to the back pressure against which the engine is working. The steam is then completely exhausted from the cylinder at constant pressure corresponding with the lower limit of temperature, work being done on the steam by the engine during exhaust, equal to the absolute back pressure multiplied by the total volume swept through by the piston. The steam is thus removed from the cylinder and the cycle is complete.

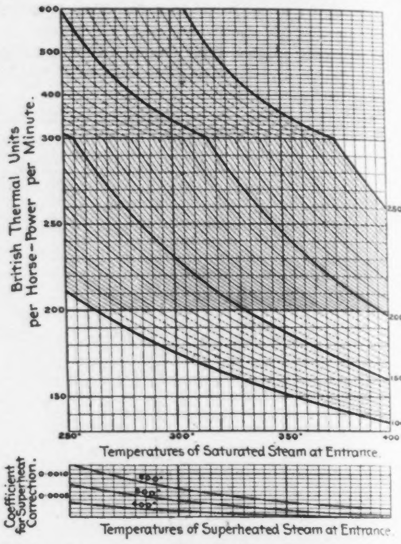

Fig. 2.—Curves Showing British Thermal Units Expended per Minute per. I. HP. by the Standard Engine of Comparison, viz., the ideal Steam-Engine Forming Part of the Rankine Cycle. (Temperatures in Degrees Fahr.)

(It will be noticed that the upper and lower portions of the diagram are to different scales; this is in order that the lower and more important part may be read more easily, and accounts for the cusps in the curves.)

The formulas for finding the heat units per minute per HP. for an ideal steam engine working on the Rankine cycle above described, are so long and complex that a diagram has been prepared from which this quantity may be found at a glance. It may be remarked that in the plotting of the diagrams for superheated steam the specific heat of superheated steam at constant pressure has been taken at 0.48. The practical use of these diagrams may be made clear by an example. Suppose it be desired to determine the B. T. U. per minute per HP. required for a "standard steam engine of comparison," taking saturated steam at 350° and discharging it at 212°. Follow up the vertical line from the figure 350 at the bottom of the diagram until it intersects the curve starting from 212° on the right-hand side. From the point of intersection follow a horizontal line to the left, and the required quantity is found to be 265 B. T. U.

Again suppose that it be required to obtain the B. T. U. per minute per HP., for the "standard steam engine of comparison," working with superheated steam at 135 lbs. pressure and 500° F. temperature, and with an exhaust temperature of 212°. Find the B. T. U. as before, using for the higher temperature the temperature corresponding to the pressure in saturated steam, then subtract from the B. T. U. per minute thus found a number to be found as follows: On the small lower diagram follow up from 350 to the curve marked 500°, and then from the point of intersection to the left on a horizontal line, by which process the correction coefficient is found to be 0.00015. Multiply this coefficient by 212, the exhaust temperature, and the product by 265, the number of B. T. U. found from the under diagram. Subtract the final product, 8.5, from the 265 B. T. U. already found. The remainder, 256.5 B. T. U. is the quantity required.

With the above explanation we believe our readers will have no difficulty in making practical use of the method of recording the efficiency obtained in steam engine trials recommended by the Institution committee. The advantages of the heat unit system as a basis of comparison have already been made familiar to American engineers to a considerable extent by the adoption of the system by the American Society of Mechanical Engineers in its standard code for duty trials of pumping engines. To state the economy of an engine merely in terms of the weight of coal or of steam which it uses per horse-power in a given time, is something like stating the width of a piece of land in paces.

In conclusion, we will again call attention to the diagram showing the various heat losses in a real and an ideal steam plant, which forms, we are inclined to believe, one of the most valuable parts of the committee's report.

While the facts it displays may be elementary to many of our readers, the general plan of the diagram may be studied with much profit by all engineers who have to do with the records and testing of steam or electric power plants. The idea of representing the energy in a power plant as a flowing stream and the various losses and dispositions of the energy as diverging branches therefrom is one which is worthy of general adoption. Facts displayed in such a graphical manner may be impressed on the minds of Boards of Directors, or other superior officers, when columns of figures and tables would be ignored. The most successful engineers are those who can deal with men as well as with materials; and the ability to present the facts of a situation forcefully and graphically is often worth as much to an engineer as all his knowledge of mathematics or materials.

LETTERS TO THE EDITOR.

Typhoid Fever in the Army.

Sir: I am directed by the Surgeon-General to acknowledge receipt of an article on "Typhoid Fever in the Army" in Engineering News, Sept. 22, 1898. The article appears to be clear and comprehensive and based upon competent knowledge of the subject. Cases of typhoid fever, diagnosed as such, were, however, not transported through the country to distribute their diarrhoeal discharges without disinfection along the tracks. Such cases were only transported by the Medical Department of the Army in hospital trains, fully equipped with all modern hospital appliances, where disinfection was as thoroughly carried out as in any civil hospital in the country. It may be true that certain undiagnosed cases sent home on sick leave proved ultimately to be typhoid infection, but such cases represented only an extremely small proportion of the typhoid cases. They were allowed to proceed on their journey simply because the symptoms manifested did not warrant the diagnosis of any grave affection. Their return was perhaps due to mistaken diagnosis based on incomplete data, but certainly was not a sin of omission or commission to be attributed to the Medical Department of the Army.

The publication of such a fair-minded and dignified article as the one above mentioned cannot fail to have a decided influence in shaping public opinion at a time when newspaper sensationalism appears to have run riot.

Very respectfully, Edward L. Munson,
Captain and Assistant Surgeon, U. S. Army,
Washington, D. C., Oct. 12, 1898.

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The Comparative Corrosion of Iron and Steel.

Sir: Your answer to R. S. W., of Milwaukee, Wis., in Engineering News of Oct. 6, is, I believe, partially incorrect. My opinion is that hard steel, which you say corrodes more slowly than iron, corrodes more than twice as fast as iron. This opinion has been confirmed in nearly every talk I have had with some of the best posted men on the subject, and I believe this is the reason why the best informed builders are now using iron instead of steel for roofing and sheet metal work. If I remember correctly Mr. M. P. Wood, in his essay on "Rustless Coating for Iron and Steel," says steel corrodes about five times fast as iron. It is certainly much easier to make paint stay on iron than on steel. As this is an interesting and important matter I for one would like to hear from any others who can speak with authority on this subject.

Very truly, C. H. H.
Cleveland, O., Oct. 15, 1898.

(We join our correspondent in asking those who have experience to discuss this topic. The literature upon the comparative liability to corrosion of iron and steel is exceedingly meager and unsatisfactory. Mr. Francis T. Bowles, Naval Constructor, U. S. N., states that "good unpainted iron or steel plates" will lose on one surface in 100 years from .30 to .50-in. thickness, if immersed in sea-water; .02 to .03-in. if in pure, fresh water, and .25 to .30-in. if exposed to the atmosphere. But, unfortunately, he makes no distinction between the iron and the steel. The action of sulphurous gases upon iron and steel, the presence of sewage in the water in which iron and steel are immersed, and the general prevailing conditions will doubtless much modify the rate of corrosion in each, and these conditions should be carefully noted in observations of this kind.—Ed.)

◆

Laying Out Turnouts and Crossings.

Sir: I wish to heartily concur in the remarks of Mr. E. D. Wileman on the subject of frogs and crossings in your issue of July 28, which has just come to my notice. He is quite right in saying that it is impossible to make a satisfactory plan of a crossing by measuring an old one in the track, or a new one either. The only way is to measure the angle of intersection of tracks, calculate angles and dimensions, and check them from a large-scale drawing.

The whole subject of turnouts and crossings has been completely befogged by a multitude of useless and cumbersome formulas. Every young engineer approaches his first turnout with fear and trembling, having imbibed the idea from the books that the subject is exceedingly difficult, whereas it is very simple, involving only problems in the use of simple circular curves, and requiring only such formulas as should be at the finger-tips of every transitman of two months' experience.

A common mistake in laying out turnouts is to begin with the location of the head-block instead of the frog point. If the latter be chosen first, and the frog angle be turned from the main line or from a tangent to the main line at that point, the turnout can be run as easily as any other curve. A table of leads and turnout curves for straight track should be constructed by considering the frog from heel to toe as one tangent, and the main line rail for stub switches, or the switch rail for split switches as another, and calculating the circular curve required to join them. Then calculate the offset between the main line and turnout curve at a point half way between the frog point and the head-block for stub switches, or heel of switch rail for split switches. This offset will be the same for the same frog, whether the turnout be on either side of tangent, taper, simple or compound circular curve, and should be used in staking the lead, as it saves the trouble of determining the degree of the turnout curve in the three last named cases.

Frogs of the same number but different lengths will of course have slightly different turnout curves, as will also stub and split switches with the same frog.

Respectfully, J. P. Newell, O. R. & N. Co.
Portland, Ore., Oct. 10, 1898.

◆

Electro-Plating of Stones and Pebbles With Metal From Water Pipes.

Sir—In the article on "Electrolysis of Water Pipes at Dayton, Ohio," in your issue of Oct. 6, I note the following quoted from the report of Mr. Harold P. Brown:

> Furthermore, the stones or pebbles near the pipes seem to be electro-plated with the metal of the pipe. This condition I have not seen at any other place, and, as far as I know, it has not been observed before.

In this connection I would refer to a letter of mine, dated March 15, 1894, and published in your issue of March 22, 1894 (Vol. 31, p. 242). With this letter I sent you samples of earth in which the redeposited metal from the pipes was plainly visible. At that time, and frequently since then, we have observed here that stones or pebbles near the pipes were especially apt to be electroplated with the metal of the pipe, whether lead or iron; and where there were moist streaks or faults in a clay soil, I have found samples of the redeposited metal extending as far as the sides of the excavation, sometimes 6 ft. from the pipes. I have been very much interested in the portions of the Dayton report which you published, more especially since our experience here agrees in many particulars with the results of the careful observations made by the experts employed there.

Yours truly, Dabney H. Maury, Jr.,
Engineer and Supt. Peoria Water-Works Co.
Peoria, Ill., Oct. 13, 1898.

(As a matter of interest in this connection we take the following additional remarks respecting the electro-plating of pebbles, etc., at Dayton, from the report of Mr. E. E. Brownell, one of the electrical experts employed by the city.—Ed.)

> Wherever any electrolytic action has attacked the cast-iron mains, there remains upon or adjacent to the mains a black substance, that is due to the nascent oxygen being liberated from the decomposed water, oxidizing the iron in the pipes, and this iron is then carried or held in solution by a solvent, which is formed by the reaction of a current of electricity upon the constituents of the soil; from this solvent the iron, lead or whatever metal it has attacked, is taken or given up to be deposited or electro-plated upon the soil and stones to the distance of several inches.

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Sir—In your issue of Oct. 6 is an abstract of reports upon the damage to water pipes at Dayton, Ohio, by electrolytic corrosion. In this there are several statements which clearly appear to be founded on misadvertence or misinterpretation of facts.

For instance, it has been fully proved by experiments made here in 1893 and 1894 that such electrolytic corrosion is a direct electrolytic action and not one in which free oxygen comes into play. Similar conclusions may be derived from the results of Mr. Farnham's experiments of about the same date. It would be a very fortunate thing if the view of the cause of electrolytic damage set forth in your abstract were correct; since, in this case, an electric pressure of some considerable magnitude would be requisite to set up the action, and careful bonding for the purpose of reducing the difference of pressure between pipes and track return would bring this below the critical value required to liberate oxygen under the existing conditions, and the danger of damage would be entirely avoided. Unfortunately, the action does not take place in this way, but was shown in the experiments referred to above to be a direct electrolytic action, which may be set up by a mere directive force. Hence results the carrying away of iron from the pipes and its deposition elsewhere. This is plainly explained in the paper read on July 11, 1894, before the Western Society of Engineers, and published in the Journal of the Association of Engineering Societies (monthly number for September, 1894). I have frequently observed an accumulation of iron or lead salts in the earth near electrolytically damaged pipes, and the phenomenon is well known amongst those who have had experience in making examinations for the purpose of prescribing alleviative measures.

Respectfully yours, D. C. Jackson.
Department of Electrical Engineering University of Wisconsin, Oct. 13, 1898.

STANDARD SPECIFICATIONS FOR STEAM BOILERS.

At the recent annual meeting of the American Boiler Manufacturers' Association, at St. Louis, the report of a committee appointed at the convention of a year ago to prepare a set of specifications for steam boilers was presented, and after extended discussion was adopted with slight changes. The report as finally adopted is as follows:

Materials.—The materials for first-class boiler work should be the standard materials as adopted at Philadelphia, by final vote recorded on page 77 of Proceedings of 1897, and as given in concise form on pages 207 and 208, Proceedings of 1897. Other materials not therein specified are given in the body of these specifications in connection with provisions for the design and workmanship of the parts to which they apply.

Riveting.—Holes should be perfectly true and fair, made so by use of clean cutting punches or drills; sharp edges and burrs to be removed by slight counter sinking and burr reaming before and after the sheets are joined together. Under side of original head of rivet must be flat, square and smooth to insure perfect contact with the plate. For rivets from ⅝ to 13-16-in. diameter allow 1½ diameters for length of stock to form the head; for large rivets allow less length. For button set on snap rivets 5% more stock may be allowed to form the driven head. Light regulation riveting hammers to be used until rivet is well upset in the hole; after that the snap and heavy mauls. For machine riveting more stock may be left for the driven head, to make it equal to the original head; this to be fixed by experiment. The amount of pressure on the die should be obout 80 tons for 1⅛ or 1¼ in. rivets; 65 tons for 1 in., 57 tons for 15-16-in., 35 tons for ¾-in. rivets.

Rivets should be tested both hot and cold by driving down on an anvil with the head in a die, by nicking and bending, and by bending back on themselves, all without developing cracks or flaws. The heads of rivets to be of equal strength with the shanks. This is fulfilled by giving the head at the periphery of the shank a height equal to one-third the diameter of the shank. A slight fillet at this point is advisable. The rivets should have a diameter about double the thickness of the thinner plate; the pitch should be about three times the rivet hole; the distance between staggered rows of rivets half the pitch; the lap for single riveting about equal to the pitch; the lap for double riveting about one and one-third times the pitch. and one-half pitch more for each addtional row of rivets.

All these are approximations; the exact dimensions to be determined by making the resistance to shear of the total rivet strength of the net or standing metal.

A factor of safety of 4½ shall be used where the tensile strength of the plate and the shearing strength of the rivets have been determined by actual tests. Where this has not been done a factor of safety of 5 shall be taken, and at most 55,000 lbs. tensible strength per square inch for steel plate and 40,000 lbs. shear strength per square inch for rivets be allowed. Rivet holes may be punched with good sharp punches and well fitting dies in American Boiler Manufacturers' Association steel up to ¾-in. in thickness. Above that thickness either punching and reaming with a fluted reamer, or drilling is advisable. The judicious use of the drift pin with light hammers in pulling the plates into place and rounding up the holes is not objectionable; but enlarging or gouging holes to a fit by driving in a drift pin with heavy hammers or mauls is condemned as a barbarous practice. When drawn into an approximate fit the holes must be trued up by means of reamers.

Calking—The old style, known as split calking, is unfit for boiler work. Excellent work can be done, both by hand calking or calking with pneumatic hammer and the Conery or round tool. Excessive calking throws undue strains on the rivet heads and must be avoided. The square nosed tool should be used only in corners where the round nosed cannot reach, and in taking up small local leaks, and extreme care is necessary to avoid nicking the lower plate. The fit should be made in the laying of the plates, the calking only to correct the natural and unavoidable roughness of the surfaces of contact. Calking edges should be prepared by bevel planing, bevel shearing or bevel chipping.

Flat Surfaces.—The rules for flat surfaces have been experimentally determined, and should be amended from time to time in the light of tests of full sized structures built up of the best modern materials and with the best modern tools and workmanship. The mathematical formulae for a plate supported on all sides have never been worked out to full satisfaction. The exact factor of safety under any empirical rules cannot, therefore, be determined. The rules of the United States Board of Supervising Inspectors approximate a factor of safety of five. And as they have given satisfactory results during past years, with materials of less excellence than American Boiler Manufacturers' Association stock, they are recommended as safe rules—viz.:

State of thickness of plate in sixteenths of an inch, thus for ½-inch plate, 8-16 or 8; then:

Assume a constant (C) for the following varying methods of construction:

C = 112 for plates 7-16 inch thick and under, with screw stays, riveted ends.

C = 120 for plates over 7-16 inch thick, with screw stays, riveted ends.

C = 140 for all plates when in addition to the screw threads in the plates a nut is used both inside and outside of each plate.

Whenever salt, acids or alkali are contained in the feed water all plates must have nuts inside and outside, in addition to the screw threads in the plate. The safe working pressure per square inch is

$$P = \frac{C \times t^2}{p^2} \text{ (where p = the pitch in inches)}$$

by formula. Or it can be expressed in the rule: Multiply the constant C by the square of the thickness of plate expressed in sixteenths of an inch, and divide by the square of the pitch expressed in inches. The quotient is the safe working pressure:

The supervisor's rules allow a still higher constant, C equals 200, based on large washers riveted as reinforce plates on the outside of the plates. But this introduces the element of doubt as to weakening by rivet holes (which has caused abandonment of this method of reinforcing manholes), and it is therefore wiser to discard it.

Bumped or Dished Heads.—Whenever a head is uniformly dished or bumped as a segment of a sphere, any radial section of same is under the same conditions of equilibrium as the circle seam of a cylinder, and as a circle seam has double the strength of a side seam (subject to percentage reduction due to riveting), it follows that the thickness of a convex or dished head should be the same as that of the cylindrical shell whose diameter is equal to the radius of curvature of the dished head. As this rule applies to a solid plate any reduction by rivet holes, man holes, etc., must be allowed for by proportionate increase in thickness.

Flanging, Bending and Forming.—The exact heat for flanging, bending and forming cannot be fixed, but must be left largely to the judgment of the flanger, since it depends on various qualities of the steel or iron, but under no circumstances should any blow be struck, or bending attempted, after that portion of the plate undergoing manipulation no longer shows red in the dark. As the danger point is what is known as blue heat, this rule must be understood to apply to parts of the plate at least 4 ins. distant from the point where the actual bending takes place or the blow is struck.

Rolling.—All rolling should be done cold, and gradually by regular increments from the straight plate to the exact circle required, and care must be taken that the whole length of the plate is rolled to a true circle. If the lap for the rivet seam is left straight instead of being brought to this true circle there is always a danger point on the line of demarcation.

Boiler Tubes.—Boiler tubes should be made of charcoal, iron or mild steel, specially made for that purpose, and should be lap-welded or drawn. They should be round, straight, free from scales, blisters and mechanical defects, and each tube subjected to an internal hydrostatic pressure of 500 lbs. per sq. in., and so stenciled. The manufacturer's name should also be plainly stenciled on each tube. The metal thickness should be as follows, but may be increased when demanded by specially high pressure or extreme lengths:

No. 13 B. W. G.	No. 12 B. W. G.
1 in., 1¼ ins., 1½ ins., 1¾ ins.	2 ins., 2¼ ins., 2½ ins.

No. 11 B. W. G.	B. W. G. No. 10.	B. W. G. No. 9
2¾ ins., 3 ins., 3¼ ins., 3½ ins.,	3¾ ins., 4 ins.	4½ ins., 5 ins.

Tests.—A section cut form one tube taken at random from a lot of 150 or less must stand hammering down vertically without cracking or splitting when down solid.

Size.	Length of test section.	Size.	Length of test section.
For 1-in. tubes.		For 2¾-in. tubes.	..1¼ ins.
" 1¼-in. "	.. ¾-in.	" 3-in. "	
" 1½-in. "		" 3¼-in. "	
" 1¾-in. "		" 3½-in. "	
" 2-in. "	..1 in.	" 3¾-in. "	..1½ ins.
" 2¼-in. "		" 4-in. "	
" 2½-in. "		" 4½-in. "	
		" 5-in. "	..1¾ ins.

All tubes should stand expanding flange over on tube plate and bending without flaw, crack or opening of the weld.

Tube Holes.—If punched, should not be full size, but allow not less than ⅛-in. on the diameter for reaming. Tube sheet should be annealed after punching, and before reaming. All holes should be slightly countersunk on both sides to prevent cutting tube by expanding and heading.

If copper ferrules are used the hole should be a neat fit for the ferrule. If ferrules are not used the hole should be 1-64 to 1-16-in. larger, according to size of tube.

Tube Setting.—Ends of tubes should be annealed in the tube mill before setting. The tube should be allowed to extend through the sheet 1-16-in. for every inch of diameter, which is ample for heading, then expanded until it is tight in the hole and no more. Excessive expanding should be guarded against. On the end exposed to direct flame, flange tube partly over the sheet, allowing part of the right angle flange or head to be completed by beading tool. The beading tool should not come in contact with the tube sheet, but work entirely on the tube. After heading, tube should be slightly expanded to counteract the loosening effect of the heading process.

Copper Ferrules.—Copper ferrules should be used in fire-tube boilers on the ends subject to direct heat. They protect the flue holes; protect the flues from crystallization on account of expanding, and make better and surer joints on account of softer metal being compressed between the two harder ones. The tubes are more readily removed on account of tube holes being larger, and when scaled, scale and sediment is removed with them, while when body of tube fits the hole it scrapes all scale and sediment off and leaves it on the inside of the boiler. Ferrules should be from 18 to 14 wire gage, according to size of tube.

Removing Old Tubes.—This depends largely on circumstances. There is always one end of the boiler where the tube is more readily removed than on the other. Some times it is convenient to drop them down and take them through a man or hand hole, then again raise them to a dry pipe hole, or take them through the hole they have been occupying. In any event, first remove the beading with a flat chisel. Be very careful not to injure the flue sheet. Then cape in past inside of flue sheet with a chisel or round back diamond point. Have sharp corners removed from tool to avoid cutting or scoring edge of flue hole. Then cave end of tube inward. The tube is then ready for removing from boiler, as circumstances may suggest. Where the tubes have not been headed over they can be readily loosened for removing by using a crimping tool made with two fingers of unequal length, between which the metal of the tube fits easily. The longer finger inside the tube forms a fulcrum; the shorter one outside crimps the metal inward.

Riveted and Lap-Welded Flues.—There are so many variations in details of construction involved in the question of the strength of such flues that a mathematical determination of their strength, which must necessarily depend on certain assumptions, is not practical. On the other hand, experimental work in testing flues of this character is necessarily very expensive and would have to cover so large an amount of ground that no private firm or corporation could undertake it, and the determination should be left to the government testing works. Your committee, therefore, deems it best for the present, and until other experimental data are available, to adopt in full sections 8 to 13, inclusive, of Rule 11 of the Board of Supervising Inspectors of Steam Vessels.

Corrugated Furnace Flues and Steam Chimneys.—The same remarks as made regarding flues apply to corrugated furnace flues and steam chimneys, and your committee, therefore, recommends the adoption, for the present, subject to amendment on the basis of further experimental data, the provisions of sections 14 and 15 of Rule 11 of the Board of Supervising Inspectors of Steam Vessels.

Stay Bolts.—Should be made of iron or mild steel specially manufactured for the purpose. If made of iron, the material should have a tensile strength of not less than 46,000 lbs., and not less than 26,000 lbs. elastic limit. Elongation not less than 22% in 8 ins. for bolts of less than 1 sq. in. net area, nor less than 20% in 8 ins. for bolts of 1 sq. in. and more in net area. If made of steel the material should have a tensile strength of not less than 55,000 lbs., and not less than 33,000 lbs. elastic limit. Elongation not less than 25% in 8 ins. for bolts of less than 1 sq. in. net area, nor less than 22% in 8 ins. for bolts of 1 sq. in. and more in net area. Stay bolts should be subjected to the following tests:

1. A bar to be selected at random from a lot of 1,000 lbs. or a fraction thereof. After being threaded with a sharp die, V-thread with rounded edges, it should bend cold 180° around a bar of the same diameter without showing any crack or flaw.

2. Another piece similarly threaded to be screwed into well-fitting nuts formed of pieces of plates to be stayed and riveted over so as to form an exact duplicate of the bolt in the finished structure. It is then to be pulled in a testing machine, and the ultimate stress carefully noted. If it fails by pulling apart, the tensile stress per square inch figured on the original net section is to be used in figuring the safe load. If it fails by shearing, the shear stress per square inch of the mean section in shear is to be thus used. This mean section in shear is found by multiplying half the thickness of the plate or nut by the mean between circumference at base and at crown of thread. The safe load to be determined by applying a factor of safety of 5 to the ultimate stress per square inch thus found.

Stay bolts should be carefully threaded with sharp, clean dies. They should be cut on a threading machine equipped with a lead screw, so that there will be no variation in the pitch of the stay bolt threads. Holes should be tapped with tap extending through both sheets and to a neat, smooth fit, just large enough so that the bolt can be put in by hand lever or wrench with a steady pull. Great care should be taken to make full, clean V-threads, rounded edges, making a close,neat fit, so that very little riveting will be required; 1-5 of diameter is proper height for projecting and riveting. Riveting is detrimental to threads in sheet and on stay bolts. In the case of hollow stay bolts a long, slender drift pin should be driven into the bore before and kept there during riveting, and afterward driven home firmly to slightly expand the bolt and counteract the tendency to loosen the thread due to the riveting, and finally removed by loosening it by slight taps of the hammer all around, or by driving out by a bar from the other end. When nuts are used on screw stays the height of thickness of such nut shall not be less than 60% of the diameter of the bolt. The largest pitch permissible for screw stays is 10 ins.

Braces and Stays.—The material in braces and stays should be fully equal to stay bolt stock. A bar not less than 10 ins. long shall be taken from each lot of 1,000 lbs. or fraction thereof and tested to destruction; the tensile strength thus found, subject to a factor of safety of 5, shall limit the tensile stress per square inch permitted on the brace in direct pull. Where such tests are not made the material shall be subject to careful inspection, and if it appears satisfactory, 6,500 lbs. per sq. in. for wrought iron and 8,000 lbs. per sq. in. for steel shall be the highest loads permitted. Welding should be avoided where possible, and where welds have to be used they are to be considered as having only 80% of the strength of the solid bar. Rivets by which braces are attached to the boiler when the pull on them is other than at right angles, should be subjected to only half the stress permitted rivets in the seams.

Manholes.—The older methods of reinforcing manholes have been found by practical tests to be defective. A ring or plate riveted on inside or outside never becomes a part of the original plate, and there are many instances where the main plate was fractured under test, while the reinforce plate or ring was as good as new. This shows that it is not possible to make the reinforce plate relieve the main plate of the portion of the load intended. This becomes worse when the metal of the reinforce plate is different in quality from that of the main plate. Besides this the rivet holes necessary for joining plate and ring together introduce a new element of weakness and uncertainty. Cast-iron reinforce flanges are of no value whatever, and are unqualifiedly condemned. The best method of forming a manhole is to cut the hole considerably smaller than required, and then flange it in with a straight flange on a radius of not less than three times the thickness of the metal. In place of attempting to rivet on a piece of plate to make up for that cut away, it is better to make the original plate that much thicker. Or the flange may be reinforced by shrinking on a reinforce ring around it, and this should always be done where the plate is ½-in. or less in thickness.

Domes.—Domes should be avoided when possible. No method of reinforcing the shell where the hole is cut for the dome gives absolute security. But where domes cannot be avoided the cylindrical portion of the dome should be flanged down to the shell of the boiler and the shell either flanged up inside of the dome or reinforced by a collar flanged at the joint, and these flanges should be double riveted.

Drums.—Drums may be put on with collar flanges of A. B. M. A. steel, not less than ⅜-in. thick, double riveted to the shell and the drum and single riveted to the neck or leg, or the flanges may be found on the legs.

Saddles or Nozzles.—Should be of flanged steel plate or of soft cast steel. The latter, however, has the disadvantage that it is frequently porous, and has not the same ductility as the shell plate, and cannot be held to be as good as flanged A. B. M. A. plate. Cast iron must not be used for any opening in which it will be in tension.

Hanging.—The boiler should be supported wherever practicable at the points where there is the greatest excess of strength. Excessive local stresses from the weight of the boiler and contents should be avoided, and therefore short lugs are objectionable. Any straps or lugs from which the boiler is suspended should be made very long on the shell, so as to insure them against distortion of any kind, and the rivets for securing them to the structure should be so proportioned as to take only one-half of the stress which is permitted for rivets in the seams. The boiler should be set in such a manner that the furnace may be rebuilt without in any way disturbing the proper suspension of the boiler. All boilers should be so set that there will be a little less water at the gage cocks than at the opposite end of the boiler.

Hydrostatic Pressure.—The old methods of testing by excessive hydrostatic pressure are condemned as barbarous, and tending to weaken the structure and disturb the proper fit of the parts. The hydrostatic test should never be used to take the place of a proper and thorough examination of the quality of materials, proportions and workmanship of the boiler. The hydrostatic test should never exceed a pressure of one-third above the regular working pressure, and under no circumstances should this excess be more than 100 lbs. per sq. in. The water used for hydrostatic test should never be less than 125° F. in temperature.

We present these specifications in this form in order that a full discussion of them may be had. We think we have done our duty, as we understand it—i. e., simply to bring into a tangible form, and as short as possible, the vast amount of information which has been contributed by all members during the discussions at our nine previous conventions. Where conflicting opinions exist we have attempted rather to harmonize them or to arrive at a just and fair compromise between them, than to assume an attitude of partisanship. We are far from believing that this is the best specification that could possibly be written to-day, but we know that it represents the average opinion of those of our members who have been most earnest in the work of this association and most desirous of establishing uniformity in excellence.

After it has been fully discussed, amended and adopted, we propose to recast it in a more concise form, leaving out matters of explanation and reciting only the rules which should govern good boiler work. It will, in our opinion, then be best to incorporate under the head of "Materials" the standard specification heretofore adopted, so that when finally completed it can be issued to the members at the joint work of the two committees.

Even then we shall consider it only as representing for the present time the average standard of good American boiler practice, and to bespeak for our work the advantage of additional amendments so that it may keep pace with all improvements tested and finally adopted in the best American boiler shops. Committee: E. D. Meier, Henry J. Hartley, George N. Riley, James Tappan, D. Connelly.

* * *

IMPULSE WATER-WHEELS OF LARGE DIAMETER.

In our issue of Dec. 10, 1895, we illustrated an impulse water-wheel for driving an air compressor at the North Star Mine, Grass Valley, Cal. The wheel was 18 ft. 6 ins. diameter, and was designed by Mr. E. S. Cobb, of San Francisco. Mr. Cobb has patented this design of wheel, and the accompanying cut shows one of still larger size (30 ft. diameter) made from his designs by the Risdon Iron & Locomotive Works, of San Francisco. It will be seen that the spokes of the wheel are all in tension, and that tangent as well as radial spokes are used. The wheel weighs about 15,000 lbs. It is entirely of steel, with the exception of the hub, and was built in four sections for convenience of shipment. It runs at the rate of 65 revolutions per minute, operating under a head of 775 ft. water pressure, and develops 330-HP. when driven by one nozzle, or 1,000-HP. with three nozzles, all of 1¾ ins. diameter. The power is used to drive a duplex, single-acting, compound air-compressor.

The buckets on the wheel are of a pattern covered by a patent issued to the Risdon Works, March 1, 1898. They are finished on the inside and polished to a smooth surface.

30-FT. DIAMETER IMPULSE WATER-WHEEL FOR A HEAD OF 775 FT.

Designed and Patented by E. S. Cobb, San Francisco, Cal.; Built by the Risdon Iron & Locomotive Works, San Francisco.

* * *

THE MACHINERY OF STEAM VESSELS ON THE GREAT LAKES.

A summary of the machinery of 1,300 steam vessels engaged in traffic on the Great Lakes has been prepared under the direction of Mr. Walter Miller, of Cleveland, Ohio. The substance of the information obtained is contained in a paper read by Mr. John H. Coffin before the Engineers' Club, of Cleveland. Referring to the survey of the 1,300 vessels in which work he assisted, Mr. Coffin said:

There are 1,150 screw propellers and a trifle over 50 paddle, or side wheel, propellers; the balance being schooners or tow barges, which are equipped with boilers and steam pumps, or hoisting or steering machinery. Of those fitted with screw propellers, 960 have solid cast wheels, 6 of them being of bronze, 8 of steel and 946 of cast iron; 185 have sectional wheels, one of them being bronze, 6 steel and 178 cast iron. Of the entire number, 1,060 of these propeller wheels are fitted on the tail shafts with straight bore and key, while only 74 are fitted on a taper end with feather and nut, the latter arrangement being more modern practice and considered by most engineers to-day to be the preferable way of fitting propellers on the shafts. Of the paddle wheels, 23 are fitted with feathered floats and 29 have solid floats.

The lack of uniformity of proportion of parts of these machines is surprising. There seems to have been no hard and fast rules for the construction of engines on the lakes, and each builder has followed his own ideas. In the item of crank-shafts, about 400 are of the solid forged type, 17 of these being of steel and 383 of wrought iron; 780 are built-up shafts, of which 23 are of interchangeable sections, 13 of them being of steel and the balance of wrought iron. Of the total number, 354 are light in section, according to Lloyd's rules for determining the size of crank-shafts. 106 cases were also found where the intermediate shafts are light of section, and 387 cases where the propeller shafts are light by these same rules; and 48 cases where the shaft couplings are reinforced, either or account of breakages or because of developed weakness. There are 296 cases where the thrust bearings are insufficient to properly relieve the crank-shaft from fore and aft strains. A perhaps more serious defect, from the insurer's standpoint, exists in the light cross-head connections, there being 446 cases where cross-head keys are too light and 54 cases where the nuts fastening piston rods in cross-heads are small. A point which seems to have been very sparingly covered by authorities on engine design, and yet which seems one of vital importance, is the bolting of cylinders to columns, of columns to bed-plates, and of bed-plates to seatings in marine engines. The strain to which each of these parts is subjected being a direct strain, the necessary strength of these parts is easily found by computation based on the steam pressure and the size of the cylinders. In these parts 340 cases were found where the cylinders are too lightly fastened to the columns, 68 cases where the columns are insufficiently secured to bed plates, and 64 cases where the bed plates are not sufficiently bolted to their seatings.

The marine fire-box boiler is the most common type, though it has lost its prestige, the Scotch boiler having rapidly displaced it; 731 boilers of this type are in use to-day. The marine water-tube boiler is of more recent date, only one having been built earlier than 1880. There are none of this type now on the lakes built between 1880 and 1890, but there are 35 vessels, built since 1890, equipped with this type of boiler, and there are several vessels now under construction which are to be equipped with this type of boiler. It is also interesting to note the gradual increase in pressures in boilers built during these several periods, as shown in the accompanying table.

295 boilers were found having patches inside and 264 having patches on the outside; 82 boilers are poorly fastened to the hulls of the vessels; 139 boilers are without stop-valves between them and the throttle-valves; there are 191 cases where the slip joints in the main steam pipes are not protected with safety guard bolts; there are 134 cases, where there are no cocks between the feed check valves and the boilers; and there are 165 cases where the feed check valves are only common pipe checks.

Table Showing Types of Engines and Boilers Built for Lake Vessels During Ten-Year Periods Since 1860; Also the Steam Pressures Employed.

	1860 to '69.	1870 to '79.	1880 to '89.	1890 to '98.
Engines:				
High-pressure non-condensing.	40	93	185	93
" condensing ...	6	10	5	4
Steeple compound.	22	62	89	39
F. & A. compound..........	5	12	154	99
Triple expansion	..	..	67	147
Quadruple expansion	..	..	1	6
Walking beams	8	10	8	7
Inclined and horizontal	1	2	7	9
Boilers: Firebox	18	97	392	224
Scotch	1	8	193	348
Water-tube	..	1	..	35
Pressures: Below 50 lbs.	5	3	2	3
Between 50 and 75 lbs......	4	19	23	10
" 75 " 100 "	5	59	122	29
" 100 " 125 "	1	25	318	173
" 125 " 150 "	..	3	52	184
" 150 " 175 "	..	1	70	161
" 175 " 200 "	..	..	..	19
" 200 " 225 "	..	1	1	12
225 lbs.	..	..	..	2
250 "	..	..	..	12
265 "	..	..	..	2
300 "	..	..	..	1

PROGRESS ON THE WATER PURIFICATION PLANT AT ALBANY, N. Y.

(With full-page plate.)

One of the most interesting pieces of engineering construction now in progress is the water purification plant at Albany, N. Y. The plans for this work were shown in our issue of Feb. 10, 1898, just before bids were received for its construction. The contract was let to T. Henry Dumary, and the Wilson & Baillie Manufacturing Co., of Brooklyn, N. Y., and the work is now at a very interesting stage. The purification plant includes a low-lift pumping-station, drawing water from the Hudson River, a 16,000,000-gallon sedimentation basin, eight covered filter beds, each 0.7 acre in area, with a combined daily capacity of 15,000,000 gallons, and a 600,000-gallon covered pure water basin. The bottom of the sedimentation basin is composed of 16 ins. of puddle, covered with 6 ins. of concrete; the slopes have first a covering of 16 ins. of puddle, then 2 ft. of broken stone, on which is 10 ins. of stone paving. The floors and roofs of the filter beds and clear water basin are of concrete; the walls of the filter compartments are lined with brick and the piers of the compartment are of the same material.

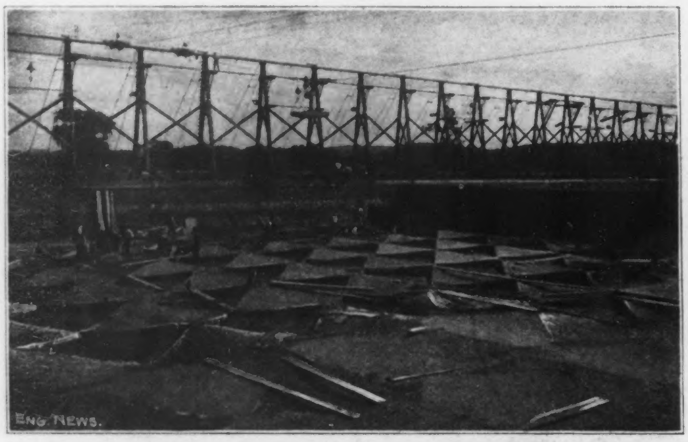

FIG. 5.—CONSTRUCTING THE INVERTED ARCHES FOR THE FLOOR OF THE FILTER BEDS.

FIG. 6.—INCLINED ENTRANCE TO FILTER BEDS.

In moving the large quantities of concrete, brick, stone, pipe and other material required for the plant, the contractors are using a "Sherman Aerial Hoisting, Carrying and Distributing Apparatus." This apparatus, as used on a much smaller scale, was illustrated and described in Engineering News of May 18, 1893. It was invented by Mr. W. D. Sherman. The present plant consists of four cableways, each of 730 ft. span, attached to cars running on trestles about 1,000 ft. in length, extending the length of each of the longer sides of the site of the plant. This apparatus hoists the material, moves it in a horizontal plane, both longitudinally and transversely, and lowers it at any desired point in an area 900 × 700 ft. A general view of one end of the plant is shown by Fig. 1, on the inset sheet. There is an engine for each cableway, as shown in the view, Fig. 2. The attendant of each engine controls the operations of the corresponding cableways from his station, in accordance with signals given him. Figs. 3 and 4 show the hoisting and transferring apparatus in more detail, as well as other parts of the contractor's plant. The trestles and cableways are also shown in the backgrounds of Figs. 5 and 6, in the text, and by the section, Fig. 10.

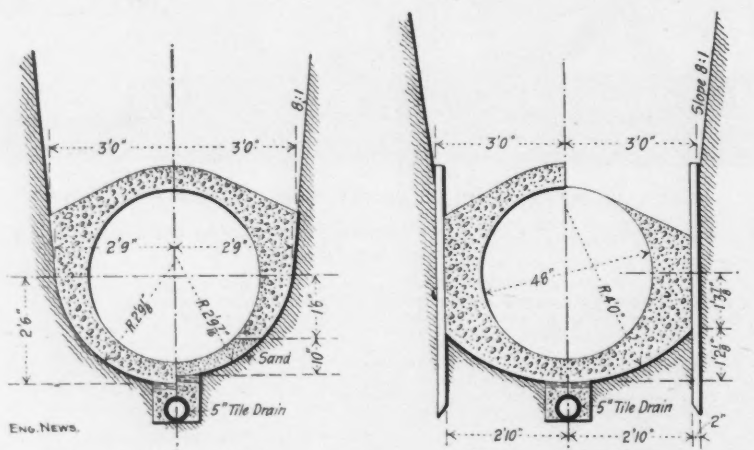

FIG. 7.—TYPICAL SECTIONS OF CONCRETE BACKING FOR 48-IN. STEEL PIPE.

The purification works are very well located for receiving material, having the river on one side, canals on two other sides, and the railway not far distant.

The sand and gravel used for concrete is dredged from the river about two miles above the work, brought down in barges and dumped in the river, alongside a dock. From the river bottom it is again dredged up and is deposited in a pile on the dock, as shown in Fig. 1. From this pile the sand and gravel are automatically loaded on conveyors, by which they are hoisted and dumped into the screen, shown in Fig. 3. Here it is washed and separated into sand, gravel and tailings, the latter being gravel above the regulation size. The tailings are passed through a crusher and added to the gravel.

The concrete is composed of approximately 1 part of cement, 3 parts sand, and 5 parts gravel, but the proportions are changed slightly as occasion demands. The cement is paid for separately, so the city may vary the richness of the concrete at pleasure. All the cement is tested in a Fairbanks machine, a sample being taken for each ten barrels, from which twelve briquettes are made. Atlas cement is used, and it is expected that about 30,000 bbls. will be required.

The sand and gravel are elevated to an upper hopper, where cement is added, and all goes to a cubical mixer, where it is turned five times dry and five times wet. There are two mixers, each with a capacity of about 1½ yds. per charge, or 200 yds. per day. From the mixers the concrete goes onto skips of ⅔-yd. capacity. The concrete mixing plants are shown in the views, Figs. 3 and 4, the cubical mixers being enclosed so they are not visible.

The cross-tracks shown in Fig. 4 are used to convey the concrete and other material along the line of the trestle to the cableways, thus saving some of the time required for moving the cableways to position for picking up material.

The steam for power is furnished by a battery of four boilers. There are ten or eleven engines in use.

The filtered water is to be delivered to the present main pumping plant, further down the river, through a 48-in. riveted steel conduit, 8,000 ft. long, encased in concrete. The pipe is made from 5-16-in. plates and has in and out joints. For a distance of 5,000 ft. the conduit is located in the bed of the Erie Canal, and for a distance of 2,200 ft. its bottom is at an average depth of 22 ft. and a maximum depth of 25 ft. below the surface of the ground. To overcome the tendency of the canal section to float, and to withstand the external pressure on the other section, the whole length of the conduit is encased in concrete. The cross-sections of concrete used for the greater part of this casing are shown by Fig. 7, types 7 and 9. A portion of the conduit 168 ft. long, beneath railway tracks, was built in a tunnel about 6 ft. wide and 7 ft. high. The concrete filling about the pipe in the tunnel was conveyed by means of a small car, running on the top of the pipe. A sketch of the car is shown by Fig. 8. Fig. 9 is a section of the tunnel, the dotted lines indicating the position of the car. The car was designed by Mr. Hilt, of Hilt, Johnson, Fitzgerald & Mulderry, contractors for the steel conduit. Nearly all the work on the conduit was done in winter. The excavation contained considerable running sand. The pipe, in excavation, was suspended in slings until the concrete was placed beneath it. It was found that concrete made with broken stone did not pack well beneath the pipe, but with gravel instead of stone, and a curved rammer, no trouble was experienced.

When a representative of the editorial staff of this journal visited the work on Oct. 5 the puddling and concreting of the floor of the sedimentation basin were about half done and stone for the slope paving was being received; four of the eight filter beds were well on towards completion, and the foundation walls for the clear water basin were in. It is expected that the four filter beds now so far advanced and the clear water basin will be put in use before Jan. 1, but that work on the other beds and the sedimentation chamber will be suspended as soon as cold weather sets in.

Mr. Allen Hazen, Assoc. M. Am. Soc. C. E., is

Chief Engineer for the plant, and Mr. Wm. B. Fuller, M. Am. Soc. C. E., is Resident Engineer. We are indebted to these gentlemen, and to the contractors, for the information here given.

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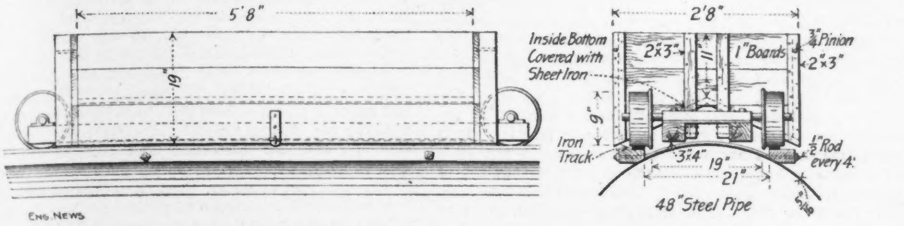
THE COAST SIGNAL SERVICE DURING THE WAR.

In a remarkably short time after the outbreak of the war with Spain there was established a thorough system of communication along the whole coast line of the United States, between the inner line of naval defence and the outer army line of coast defence. The establishment of this system in so short a time called forth the unstinted praise of the European military authorities, and the report of Captain John R. Bartlett, U. S. N., Chief of the Navy Intelligence Bureau, indicates how these results were secured.



Side Elevation.

End Elevation.

FIG. 8.—CAR USED IN DEPOSITING CONCRETE AROUND THE 48-IN. STEEL PIPE IN TUNNEL.

Captain Caspar F. Goodrich, U. S. N., then President of the Naval War College, began work upon the plans on March 15, 1898, and in less than one month he announced that he was ready to put them into operation. He was not permitted to incur the expense, however, until the Spanish fleet was well on its way to Cuba and attacks by Spanish vessels upon the Atlantic seaboard seemed probable. On April 22, permission having been granted, he sent the following telegram to the commanders of the naval militia, from Massachusetts to Louisiana:—

> Establish and man coast signal stations already determined by me. Lowest bids, greatest economy, most speed necessary. Let crews sign temporary agreement pending receipt of enlistment forms. No heliographs needed. Send further communication to Superintendent, New York.

On April 23 Captain Goodrich was ordered to sea on the "St. Louis," and Captain Kane took his place, until May 9, when Captain John R. Bartlett, then Chief Intelligence Officer, was placed in charge, and to him belongs the credit of building up the system. Within twenty-four hours after the receipt of the above telegram the men had reported at their stations, and in a week they were fully established and equipped with apparatus ordered in accordance with the instructions of Captain Goodrich.

The preliminary organization covered eight districts and 36 signal stations, officered and manned from the State Naval Militia, with 18 officers and 210 men in all. The station equipment consisted of the international code flags and books, "wigwag" flags, "shapes" (cones and drums), powerful telescopes and binoculars, torches and an improvised Ardois system of red and white lights. At each station quarters were built for the crew, and a 90-foot mast, with a 40-foot yard, was erected; in some cases signal towers were built. There was also a telegraph or telephone outfit, or both, which connected with the Life Saving Service lines along the beach. The station crew included one chief quartermaster, three second-class quartermasters and one landsman. These men were divided into watches and armed with Springfield rifles; there was a daily and weekly routine of exercise and drill, and notes of this were entered into the log. Once in every two weeks each station was inspected by an officer, who reported to headquarters.

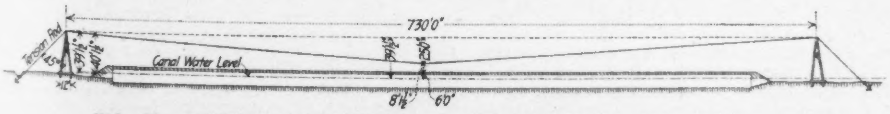


FIG. 10.—SECTION OF HOISTING AND DISTRIBUTING APPARATUS.

The services of these 210 men were efficiently supplemented by the watchful crews of the life-saving stations, including 1,443 men, and the 850 light-keepers along the coast. Including 33 observers of the Weather Bureau there was thus an aggregate of 2,536 men on the lookout for the approach of suspicious vessels. Tests of wires were made at the beginning of each watch, and a daily telegram was sent from each station to the district headquarters. By arrangement with the telegraph companies the Coast Signal Service had the right of way over the wires by simply notifying the company in advance. Arrangements were also made at each district headquarters to send notice of the presence of an enemy to the auxillary naval force and the principal forts and batteries in the district.

Captain Bartlett says that from the practical operation of the Coast Signal Service for three months he is confident that it would have well served the use for which it was established—to observe and report the approach of an enemy's vessel or fleet. It was frequently of use in keeping the Navy Department advised of the movements of its own vessels, and was particularly serviceable in the case of the battleship "Oregon." It also kept the several navy yards advised in advance of the approach of vessels, and enabled them to make preparations for their reception The most valuable result, however, was the determination of points where signal stations are necessary, in time of war, to supplement the systems of Life-Saving, Lighthouse and Weather establishments. Captain Bartlett recommends a permanent service of this nature, as being in fact an integral part of a naval coast-defence system. Each life-saving station should be made a coast signal station, and the crews should be drilled in the "wigwag" code and naval night signals. The same should be done for lighthouses and certain of the stations of the Weather Bureau. Permanent Coast Signal Stations should be established at designated important points, and equipped with three-armed semaphores and an acetylene gas "Ardois" system for night work.

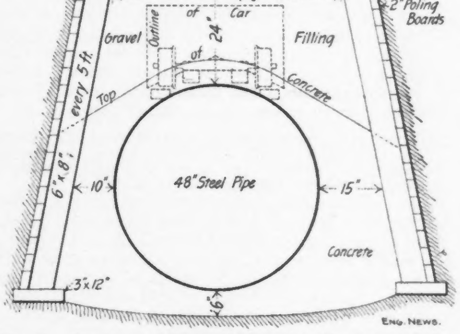


Fig. 9.—Section of Tunnel Showing Position of Car.

THE WESTERN UNION TELEGRAPH CO. reports for the year ending June 30, 1898, total gross earnings of $23,915,732, an increase over 1897 of $1,276,873, and net earnings of $6,090,151, an increase of $357,848. During the year the company sent 62,173,749 messages, against 58,151,684 in 1897. This total has only been twice exceeded —in 1893 with 66,591,858 messages, and in 1892 with 62,387,278 messages. The present mileage of wire is given at 874,420, against 841,002 miles in 1897; there are 22,210 telegraph offices, an increase of 441. The average toll per message is 30.1 cts., against 30.5 cts. in 1897 and 30.9 cts. in 1896. The cost per message is rising, however; this was 24 cts. in 1896, 24.3 cts. in 1897, and was 24.7 cts. last year. In this case the decrease in average tolls and increase in sending cost is ascribed to the large number of Government and press messages sent during the war with Spain.

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GERMAN ADVANCED TECHNICAL EDUCATION in Saxony is commented upon by U. S. Consul Monaghan, of Chemnitz. He says that with a population of 3,783,014 Saxony has 1,953 of these schools attended by 75,358 boys and 1,699 girls. There are besides these 39 higher industrial schools, with 10,660 scholars; 112 industrial technical schools, with 10,119 scholars; 44 commercial schools, with 4,781 scholars; 11 agricultural schools, with 691 scholars, and 18 technical schools for girls, with 2,445 scholars. Compulsory education is established for graduates of common schools, and the hours of attendance are early in the morning or a certain number of afternoons in each week. Boys make a special study of the trades in which they are occupied.

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THE PEOPLE'S TELEPHONE CO., of New York, has been incorporated and the following officers have been elected: Darwin R. James, President; E. S. A. de Luna, Vice-President; Silas B. Dutcher, Treasurer; Frank S. Gardner, Secretary. This new corporation originated with some influential members of the New York Board of Trade who have been working to reduce telephone rates for some years past. The company promises to give its subscribers unlimited service in Manhattan for $100 per year, as compared with $240, the present charge, with free use of public pay stations for 100 calls per year for each subscriber. The message service will be cut from $90 for 600 messages to $40 for 400 messages; for a larger number of messages the rate will go as low as 4 cts. per message. The residence rate for service on private wires will be $30, and $1 per month on group lines. In Brooklyn the unlimited service for business places will be $75 per year instead of $150 as now charged. The new corporation says that its appliances and system are tested in over 2,000 independent exchanges now in operation in the United States, and all its instruments will contain the newest devices in receiver, transmitter and switchboard, with metallic circuits throughout the system.

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THE MANHATTAN STEAMSHIP CO., which now maintains a weekly service to Rockland, Camden, Belfast, Bucksport and Bangor, Me., and to Eastport and St. John, has secured four large lake steamers for this Atlantic service. Counting the fleet lately acquired by the Atlantic Transportation Co. for a similar service, 55 lake vessels, of from 1,400 to 2,500 tons capacity, have been purchased from the lake fleets to trade between Atlantic ports. The causes of this movement is the scarcity of available steamers on the Atlantic and the trade rivalry in barge traffic. The Atlantic Transportation Co. says that it was forced to secure lake vessels by the antagonism of other coal lightering companies, which advanced rates when this company needed more vessels than it owned in the conduct of its own business. The effect of the new method of coal transportation will eventually be to break up the single trip chartering business for coal and enable coal shippers to know exactly what rate they will be called upon to pay for transportation. They can thus quote prices "alongside" instead of "f. o. b.," as at present.

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A NEW YORK COMMERCE COMMISSION, appointed by Governor Black, is now investigating the existing dock system in this city. This commission is made up as follows: Ex-Mayor C. A. Schieren, of Brooklyn; Andrew H. Green, Alex. Smith, Hugh Kelly and C. C. Shayne. At the first meeting on Oct. 18, Mr. George S. Greene, Jr., for many years Chief Engineer of the old Dock Board, said that it was the policy of the Dock Department to gradually acquire the entire water front and to improve or lease it. This department had an income of $2,000,000 per year, and in a couple of years this will be increased by from $300,000 to $500,000. Of this sum only about one-fourth is paid by steamship companies for use of the city water front. As a general thing rentals of private dock property are higher than the rentals charged by the city. The lessees of private docks are nearly all domestic companies not engaged in foreign trade. Mr. Greene did not believe in free docks, as offered in other cities; these free docks were usually owned by railway companies who thus sought to attract trade for their railway lines and in this way really obtain a rental. The advantages of Staten Island for commercial purposes were urged by Erastus Wiman; and Mr. Charles Stoughton advocated a deep waterway in the Harlem River, to cost $1,750,000.

THE SUBSIDIES TO THE FRENCH LINE of steamers, the Compagnie Generale Transatlantique, were originally granted in 1857. The government was to pay annually to the company the sum of $1,794,900, of which sum $579,000 was applied solely to the steamers running between Havre and New York. This was an average subsidy of $10.77 per nautical league on the New York line; with a minimum speed exacted of 11½ knots and 26 trips per annum. In 1873 the amount of the New York subsidy was increased to $703,292; but the trips were increased to 40 per year, or $8.50 per nautical league. In 1886 this franchise was renewed for 15 years; but sailings were made weekly and a minimum speed of 15 knots was exacted. To encourage the building of larger and faster steamers a bounty of $2.32 per gross ton was allowed for every tenth of a knot of speed in excess of 15. This speed bounty, however, was not to exceed $231,600, and this amount has been paid since 1892. The subsidy was also raised to $1,057,640 per annum, and with speed bounty added this is equivalent to $11.66 for every nautical league steamed. The Steamship Company is now building three new mail steamers which are to have a minimum speed of 22 knots under forced draft. The fleet of the Compagnie Generale Transatlantique numbers 63 ships of a gross tonnage of 166,797, developing 169,850 I. HP. The assets of the company amount to $28,273,314, in steamers, real estate, supplies, outstanding accounts and cash. The capital stock is 80,000 shares of 500 francs each, on which they paid in 1897 15 francs dividend, or about 3%; there are also $18,231,448 in 3% bonds, with some minor securities. The legal reserve and insurance fund is $1,944,197; the net earnings for 1897 amounted to $238,769.36. The total receipts of all kinds in 1897, including bounties and subsidies, was $8.879,538, and the total expenses were $7,647,784, leaving an excess of receipts of $1,231,754. The gross receipts decreased $487,442 in 1897, but the expenses were also decreased by $359,769. During 1897 the ships of the company made 681,342 marine leagues; and the Havre-New York line made an average speed of 16.72 knots, as compared with an average of 13.13 knots for the line to the Antilles. The foregoing statement is condensed from a more detailed one made by U. S. Consul A. M. Thackara, of Havre, and contained in the "Consular Reports" for October, 1898.

A WIRE-MEASURING WHEEL, for finding the length of wire used in obtaining the depth of a shaft, has been devised by Mr. O. Brathuhn, and is described in the "Berg und Hüttenmannische Zeitung," 1898, p. 155. The brass wheel used had a diameter of 35 ins. and was 0.3-in. thick, with a rounded groove in the rim for the wire. The circumference of the wheel was divided into 100 divisions; and by the aid of a pointer and vernier a 1-10,000th part could be read. To the axle of the wheel was attached a counter registering complete revolutions; and a small spirit-level on the cast bed-plate of the wheel enabled the plane of the wheel to be kept vertical. In this plane was a ratchet winch for lowering or raising the wire passing over the wheel. Before measuring, the wire was weighted and hung over the wheel into the shaft for several hours, until it was fully stretched. By means of a level at the shaft-bottom a fixed point on the bottom of the wire was then marked by tying on a piece of thread; and another level at the top was adjusted to sight the wire. With the counter at zero the position of the pointer is read and the wire is carefully hauled up. When the top level strikes the thread-mark the wheel is clamped and the number of revolutions noted. The difference between the first and final reading, multiplied by the value of one revolution, is the required depth. The apparatus is sufficiently accurate and costs about $75.

BOOK REVIEWS.

INSPECTION OF THE MATERIALS AND WORKMANSHIP EMPLOYED IN CONSTRUCTION. A reference book for the use of inspectors, superintendents and others engaged in constructing public and private works. Containing a collection of memoranda pertaining to the duty of inspectors, quality and defects of materials; requisites for good construction; methods of slighting work, etc. By Austin T. Byrne, C. E., author of "Highway Construction." New York: John Wiley & Sons. Cloth, 7 × 4¼ ins.; pp. 540. $3.00.

This is a new and useful handbook compiled from recent but very widely scattered materials, and Mr. Byrne has performed an excellent work in here bringing together in compact and accessible form a large amount of information necessary for the successful performance of the varied duties connected with the inspection of materials and workmanship. Structural materials are first very clearly described and classified; with the requisites of good materials, tests for fitness and methods of detecting qualities that make them unfit for use in public works. This list includes stone, brick, cement, timber, metals and miscellaneous materials. Fastenings of all kinds come next, covering nails, screws, pins, bolts and nuts, rivets and rivet inspection. Under the general head of construction we have earthwork in all its forms, foundations, masonry and stone-cutting, mortars, carpentry, iron and steel work, plumbing, roofing, plastering, glazing and painting. Water supply, sewerage and paving are discussed under separate chapter heads. Without entering into detail, it is sufficient to say that under each of these many heads the author briefly, but clearly, indicates to the inspector the quality of material and workmanship required in general good practice, and he also points out the methods by which certain kinds of work are scamped. An excellent feature of the work is the introduction of nearly every chapter by a definition of the use and a description of the tools employed in that special class of work; and this feature is supplemented by an appendix covering the definitions of terms used in general construction. As this book is essentially a handbook for inspectors, the chapters on water-supply, sewerage and paving, deal only with the qualities of the materials employed and the methods of placing them in the work; but throughout the whole book hints and suggestions abound that are quite as useful to the practicing engineer. In fact, it is difficult to find a book of similar bulk that contains more generally useful engineering information upon detail matters occurring in practice. It is supplemented by a number of tables of common use, such as weights and measures, specific gravity and weight of materials, mensuration tables, trigonometrical functions, etc. From the long list of authorities consulted, given in the end of the handbook, it is evident that Mr. Byrne has put patient and intelligent work into its compilation; and this and the contents of the book itself warrant him in the assertion that it is up to date and embodies the latest available practice in construction and inspection.

THE INDICATOR HANDBOOK.—A Practical Manual for Engineers. By Charles N. Pickworth. Part I. The Indicator, Its Construction and Application. Manchester: Emmott & Co., Ltd.; New York: D. Van Nostrand Co. Cloth, 12mo.; pp. 130. $1.50.

This is an English book, but much of its contents are from American sources, such as the descriptions of instruments made in this country and abstracts of discussions of errors due to long pipe connections, inaccurate reducing motion, etc., which have appeared in our technical press. The book is one of the best that we have seen on the subject. It contains good descriptions of all the standard forms of indicators, including the most recent improvements, and of a great variety of indicator rigs. There is a good chapter on errors of indicators, and another on errors of reducing motions. The book might be improved by expanding the brief account of the method of testing springs, showing the use of a steam gage tester for checking the readings of a gage when it is used for testing indicators. The illustrations have the muddy appearance which is common in English text books.

THE JOURNAL OF THE IRON AND STEEL INSTITUTE. Vol. 53, No. 1. 1898. Edited by Bennett H. Brough, Secretary. London: E. & F. N. Spon, New York: Spon & Chamberlain. 8vo.; cloth; pp. 606.

This volume contains the proceedings of the London meeting of the Institutė, in May, 1898, an extended obituary notice of Sir Henry Bessemer, which includes a reprint of his famous paper read at the Cheltenham meeting of the British Association for the Advancement of Science, Aug. 13, 1856, "On the Manufacture of Iron and Steel Without Fuel," and the usual Notes on the Progress of the Home and Foreign Iron and Steel Industries.

The titles of the papers read at the London meeting are: "On the Use of Blast-furnace Gas for Motive Power," by A. Greiner; "On Coking in By-product Ovens," by J. H. Darby; "On the Relative Merits of Limestone and Lime in Blast-furnace Practice," by C. Cochrane; "On Steel Permanent Way," by R. Price-Williams; "On the Iron Ore Deposits of the Ural," by H. Bauerman; "On the Crystalline Structure of Iron and Steel," by J. E. Stead; "On Allotropic Iron and Carbon," by E. H. Saniter; "On Brittleness in Soft Steel," by C. H. Risdale; "On the Solution Theory of Iron and Steel," by Bacon H. Juptner.

THERMODYNAMICS OF THE STEAM ENGINE AND OTHER HEAT ENGINES. By Cecil H. Peabody, Professor of Marine Engineering and Naval Architecture, Massachusetts Institute of Technology. Fourth edition. Rewritten and reset. New York. John Wiley & Sons. London: Chapman & Hall, Ltd. 8vo.; cloth, pp. 522; $5.

The first edition of this work was published in 1889. It is one of the best American treatises on thermodynamics and is largely used as a text book in engineering schools and as a reference book by engineers. The present edition contains much matter not in the earlier editions, and much of the text of the earlier editions has been changed in revision. More space than before is given to the subject of gas engines. The first seven chapters, covering about one-third of the work, are devoted to mathematical treatment of the principles of thermodynamics, including gases and vapors. The remainder of the book treats of flow of fluids, injectors, hot-air and gas engines, the steam engine, compressed air and refrigerating machines. Over 200 pages are devoted to the subject of the steam engine, and much of the matter given under this head is of a practical nature, outside of what is usually included in works on thermodynamics, such as economy of actual engines, cylinder condensation, testing of engines and friction of engines. The value of a book on thermodynamics, to the practicing engineer, is enhanced by the amount of matter contained in it which is not thermodynamics, and this work is well supplied with such matter. The information concerning economy of engines is brought down to the latest dates. We notice particularly a discussion of the Diesel oil motor, the latest of the petroleum engines. We would suggest that the theoretical part of the book might be improved for use as a reference book by adding a page or two giving in brief form the meaning of all the symbols used in the formulae.

THE COFFER-DAM PROCESS FOR PIERS.—Practical Examples from Actual Work. By Charles Evan Fowler, M. Am. Soc. E., Bridge Engineer. John Wiley & Sons, New York. Cloth, 6 × 9 ins.; pp. 159; illustrated; $2.50.

This is the first time we have seen this subject separately treated, and Mr. Fowler imparts much useful information in the actual examples of work done here described and well illustrated. Commencing with the history of early bridge foundations, he describes many varieties of coffer-dams and caissons as found in comparatively late engineering practice. In each case the methods followed and results obtained are briefly but clearly given. The several chapters cover timber and sheet pile construction, metal construction, the pumping and dredging plant, and separate chapters upon the character of the foundation soil, the use of concrete and the general location and design of piers. An interesting table notes 44 coffer-dams, used on generally important works, and gives the conditions of current, head of water, character of bottom and general dimensions and thickness of puddle. As Mr. Fowler says in his introduction, he takes the great part of his examples from current engineering literature but he does a good work in thus bringing them together in one book.

TUNNELING SHIELDS. (Emploi du Bouclier dans la Construction des Souterrains.)—By Raynald Legouez, Ingenieur des Ponts et Chausses. Paris: Beaudry & Co. Cloth; 8vo.; pp. 440; illustrations, 337. Price, 20 francs ($4).

This book is the first to bring together details of the various forms of shields used in tunnel excavation and of the works executed by means of these shields, although most of the shields and works have been described in the technical papers. The first design and use of the shield is attributed to Isambard Brunel ("a French engineer who emigrated to England"). To English engineers is given the credit for simplifying the design (even beyond reasonable limits), while to French engineers is given the credit for the use of oval shields and of substituting masonry for metallic lining behind the shields. American engineers are said to have followed on the English lines.

The first 14 chapters deal with individual shields and the works executed by them, commencing with Brunel's Thames Tunnel of 1825, and including the Mersey tunnel, the London and Glasgow underground railways; the Hudson, St. Clair and East River (gas) tunnels in the United States, and the Clinchy sewer tunnels near Paris. Many of these are dealt with in considerable detail, both as to the plant used and the progress of the work, while other tunnels are also mentioned. The next chapter discusses the design and construction of the shields, the dimensions, air pressure employed, safety appliances, etc. The tunnel lining is then taken up, and it is stated that Brunel in England and Beach in America (Broadway underground railway) employed a brick lining. In the Clichy tunnel, the shield was followed by a steel centering, upon which was built the brick lining, but for the extension of that tunnel under the city of Paris the shield itself formed the centering. The iron lining has the advantages of requiring a minimum of excavation outside the inner line of the finished tunnel, but it is very costly and involves an enormous weight of material. A lighter iron lining with an inner lining of masonry is not approved. The various operations connected with the progress of the work are described, and tables of cost are given.

The book is well printed and fully illustrated with line and half-tone engravings, but in many of the latter the figures are too small to be read conveniently, which is a defect very common to French engravings of this kind. For English and American works, dimensions and weights are given in metrical and duodecimal measures. The table of contents occupies about eight pages, but there is no index, which is a great defect in a book of this character, as we have several times pointed out.

REPORT OF THE CHIEF OF THE WEATHER BUREAU. U. S. Department of Agriculture. 1896-97.—Washington, D. C. 1897. Cloth; 11½ × 9 ins.; pp. 431; maps and other illustrations.

This report of Mr. Willis L. Moore, Chief of Bureau, under the head of administration, states that the cost of running the bureau, in 1896-97, was $883,772, as compared with $993,520 expended on the weather service in 1883. But the work now performed is largely in excess of that done in 1883. In the fiscal year reported upon, 4,315,000 weather maps were issued; 51,694 daily forecasts and warnings were forwarded by mail, telegraph and telephone; about 8,000 places reported climate and crop conditions; about 3,000 voluntary observers now make daily readings of U. S. Standard thermometers and rain-gages, and 253 stations on the Great Lakes displayed storm signals. The bulk of the report is devoted to the records of results for the year in tabular form, with explanatory text and maps graphically showing the year's record. The rainfall of the United States is very fully treated in a separate article by Mr. A. G. Henry, Chief of Division; and Mr. Park Morrill, Forecast Official, contributes a lengthy illustrated paper upon the floods of the Mississippi River and its main tributaries.

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