ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

VOL. XLI. No. 7.

TABLE OF CONTENTS.

NEW YORK STATE CANAL CONTRACTS have been reported upon by Messrs. Partridge and Bond, respectively Superintendent of Public Works and State Engineer. To complete the work on all the contracts already awarded under the $9,000,000 act will require, it is estimated, the sum of $3,780,816 in addition to the proceeds of the $9,000,000 bond issue. This estimate includes an allowance of $236,600 for engineering expenses and $101,400 for inspection.

THE DISMAL SWAMP CANAL has again been put into serviceable condition at a cost of about $1,000,000 and will, according to report, be opened to navigation about March 1. The work was done by the Lake Drummond Canal & Water Co., the present owners of the charter. It is 22 miles long, with a depth sufficient for vessels drawing 10 ft. It connects Chesapeake Bay with Albemarle Sound, and affords access to 2,500 miles of river and bayou navigation in the Carolinas. The original canal was completed in 1882, and cost $1,800,000, slave labor being used in its construction. It was built by the state of Virginia and the national government, each bearing half of the expense.

THE SHIPS NOW BUILDING FOR THE NAVY are, according to the latest reports given out by Chief Constructor Hitchborn, in the following state of advancement: Battleships "Kentucky" and "Illinois" at Newport News, 80% and 62% respectively; battleship "Alabama" at Cramps', 74%; battleship "Wisconsin" at the Union Iron Works, 59%; cruiser "Albany" at Armstrong's, England, 80%. The three torpedo-boats "Dahlgren" at Bath, Me., the "Fox" at Wolff & Zwicker, Portland, Ore., and the "Craven," also at Bath, Me., are given as 93%, 96% and 89% respectively.

THE CLIMATE OF THE PHILIPPINE ISLANDS is, according to report made by the U. S. Weather Bureau, not nearly so bad as it has been painted. This report is taken from observations made at the Observatorio Meteorologico de Manila, covering from 17 to 32 years, and gives the following figures:

Temperature, degrees F.:	
Mean annual	80°
Warmest month	82°
Coolest month	79°
Highest	100°
Lowest	60°
Humidity:	
Relative per cent	78
Absolute grains per cu. ft.	8.75
Wind movement in miles:	
Daily mean	134
Greatest daily	204
Least daily	95
Prevailing wind direction—N. E., November to April; S. W., May to October.	
Cloudiness, annual per cent	53
Days with rain	135
Rainfall in inches:	
Mean annual	75.43
Greatest monthly	120.98
Least monthly	55.65

In the region of Manila the hot season extends from March to June, with a maximum temperature in May of from 80° to 100° in the shade. The cold season extends through December and January, with a minimum temperature of from 60° to 65°, while it seldom goes above 75°. From November to February the weather is delightful, with a clear, bright sky and dry, cool air. During this period woolen garments may be worn with comfort in the morning and evening.

THE PAN-AMERICAN EXPOSITION of 1901 will receive $500,000 from the State of New York, provided the bill now pending before the state legislature at Albany becomes a law. A committee appointed from Buffalo to canvass that city for subscriptions succeeded in raising $500,000 in three hours, acording to reports. Up to the present time the exposition fund has reached $1,400,000. A bill has been introduced in Congress appropriating $500,000 for the government portion of the exposition.

THE CONTRACT FOR THE CONSTRUCTION OF THE Boston Elevated Ry. structure in Washington St., and Main St., Charlestown, was let to the Pencoyd Iron Works, Pencoyd, Pa., on Feb. 8. The contract calls for the completion of the work by Oct. 1, 1899. The total length of this portion will be 13,870 ft. and the weight of metal work 8,300 tons.

THE MOST SERIOUS RAILWAY ACCIDENT OF THE week occurred on the South Carolina & Georgia R. R., 11 miles south of Charleston, S. C., on Feb. 14. A work engine carrying 10 men was running towards Charleston at a speed of about 15 miles per hour when the rails spread, throwing the engine into a ditch at the side of the track. Two of the men were killed and eight seriously injured.

A SERIOUS RAILWAY ACCIDENT occurred on the Pittsburg & Lake Erie R. R. near Fleming Park, Pa., on Feb. 13, in which the fireman of an express train was killed and 17 passengers were badly injured. According to press reports the accident was due to a broken rail, which threw the train off the track when running at a high rate of speed.

THE LOAD OF ICE WHICH COLLECTED ON THE decks of the "Germanic" of the White Star line on her last voyage, owing to the intense cold and rough weather, together with an open coaling port on her starboard side, caused the vessel to careen and sink at her pier in New York city on Feb. 13, while the cargo was being unloaded. The vessel lay in shallow water so that the upper part of her hull was not submerged. Work is in progress pumping out the flooded compartments and it is expected that she will be delayed only a few days from starting upon her next voyage.

A SNOW SLIDE OCCURRED at Silver Plume, Colo., on Feb. 12, which resulted in the death of 10 persons, the injury of several others, and the destruction of considerable mining property. The slide measures 300 ft. across, from 50 ft. to 75 ft. deep and fully 1,500 ft. long.

ROOF TANKS placed on the roofs of factories or other buildings for storing water should be inspected at intervals to see that they are in safe condition. In a recent case reported by the Boston Manufacturers' Mutual Fire Insurance Co., a roof tank for supplying the automatic sprinkler system burst without warning, and did considerable damage. It was found that the hoops had become so rusted, notwithstanding frequent painting, as to be materially weakened. In another recent case a 10,000-gallon tank supported by a wooden trestle on the floor of a brick tower proved too heavy for its support and fell upon the roof of a storehouse, and continued its course through two floors to the ground.

A NEW DUMP-CAR is now being manufactured which resembles an ordinary gondola car and has a level floor for its entire length and width. The entire load can be dumped in a few moments or can be shoveled out in the ordinary way. The car is available for such material as coal, ore, gravel, sand, grain, etc. No load is carried on chains, an interlocking swivel bar resting on the sills being substituted. The only chains used are those for drawing back the dumping traps. These traps are so arranged that the load can be thrown between the rails or on either side of the track. The first of these cars is being built for the Caswell Car & Improvement Co. by T. W. Harvey, Jr., of Chicago.

DREDGING FOR GOLD has been carried on very successfully for some years past on several rivers on the Pacific slope. The Hammond Mfg. & Dredging Co., of Portland, Ore., has operated a bucket dredge of 2,000 cu. yds. daily capacity on the Snake River during the past season, and has recently completed a similar machine of 2,500 cu. yds. daily capacity for the Golden Giant Hydraulic Mining Co., to operate on the same river. Some of the California rivers emptying into San Francisco Bay have of late also been yielding a rich harvest.

CIVIL SERVICE EXAMINATIONS for steam engineers and other positions in the New York State Government service will be held on March 1, 1899, in various cities throughout the state. Intending competitors must file applications in the office of the New York Civil Service Commission at Albany, N. Y., before Feb. 28. No one will be admitted to examination without the official notice from the Secretary of the Commission.

ELECTRO-MAGNETS FOR RAISING STEEL RAILS will be tried on the Ohio River at Meriman, where a barge loaded with steel rails was sunk in the channel. The work will be done by the Langton Electric Co., Pittsburg, Pa. A suitable crane boat will be equipped with dynamos and large electro-magnets, encased in water-tight coverings, capable of lifting 4,000 lbs. each. These will be suspended from cranes and connected to the dynamos by flexible cables.

A BILL TO ABOLISH THE NEW YORK CITY BUILDing Commission, recently appointed by the Municipal Assembly, and to repeal the Building Code adopted by it was introduced in the New York Legislature on Feb. 6. A second bill was also introduced, which provides that a new commission consisting of 11 members shall be appointed by the Governor, as follows: A member of the Board of Buildings, Chief of the Fire Department, one representative of the Health Department, one member of the Tenement House Commission, who shall be an architect; one representative of the Board of Fire Underwriters, one civil engineer, to be chosen from a list of 3 names to be submitted to the Governor by the American Society of Civil Engineers; 3 architects, to be chosen from a list of 9 names to be submitted to the Governor by the New York Chapter of the American Institute of Architects; one practical builder of at least 5 years' experience in the construction of modern fireproof buildings and one attorney and counsellor at law who has been admitted to practice in the state of New York for at least 5 years. The Commission is to report to the Legislature not later than Jan. 15, 1900, a code of building laws for New York city.

THE 30 FOREST RESERVATIONS OF THE UNITED States embrace an area of 40,000,000 acres in 13 states and territories. Seven are in the state of California, the largest of which, the Sierra Forest Reserve, includes 4,006,000 acres. Within the past 35 years it is estimated that 11,000,000,000 ft. B. M. of timber on public land have been destroyed by forest fires.

950,000 FT. B. M. OF SELECTED TIMBER was shipped from San Francisco on Jan. 28 to be used by the German government in the construction of new war vessels. The pieces were from 24 to 54 ft. long by 4x4 ft. and they were absolutely knotless and apparently without a single blemish. The cargo was valued at $27,550, or 4.66 cents per ft., while ordinary lumber sells for about 2.75 cts. per ft.

THE SMEDLEY CIVIL APPROPRIATION BILL, as reported to the House of Representatives on Feb. 6, contains the following items of interest to engineers: The Coast and Geodetic Survey is to receive for field expenses, $189,500; repairs and maintenance of vessels, $29,600; pay and subsistence of seamen, $27,500; outfit and equipment for "Pathfinder," $15,000; salaries, $136,090; office expenses, $33,000. The Interior Department receives for the protection of timber on the public lands and the care and management of forest reserves, $285,000. The department also receives for surveys and resurveys of public lands, $325,000. The Geological Survey receives $677,100, of which $200,000 is for topographic surveys, $50,000 is for stream gagings, $130,000 is for surveys of forest reserves, and $110,000 is for geological surveys. The Deep Waterways Commission receives $60,000 for the completion of its surveys and estimates for a Great Lakes and Atlantic ship canal. The Watertown arsenal receives $10,000 for care and operation of the testing machine and $5,000 for the purchase and erection of a new 100-ton Emery testing machine. The Lake Survey receives $28,000. The California Debris Commission receives $15,000.

THE CHESAPEAKE & OHIO CANAL sale, announced for Feb. 7, resulted in only one bid. Mr. C. K. Lord, President of the Consolidated Co., offered $300,000 for the canal, agreeing to give bonds to maintain it as a waterway for 20 years. The Maryland Board of Public Works decided to reject the bid on the ground that it was made in the interest of the Baltimore & Ohio R. R. Co.

TIES FOR THE SIBERIAN RAILWAY will be supplied by Japanese lumber dealers to the extent of 4,000,000 pieces at the rate of 1 yen per piece. The ties will be cut in the province of Hokkaido, and are to be supplied at the rate of 800,000 pieces per year.

THE IMMEDIATE LAYING OF A PACIFIC CABLE to connect the Hawaiian Islands and the Philippines with the United States is urged by the President in a special message to Congress, Feb. 10. It is estimated that two years at least will be required for the completion of the cable.

STONE ARCH BRIDGE AT HYDE PARK, N. Y.

In our issue of Nov. 10, 1898, we illustrated two Melan arch bridges erected for Mr. F. W. Vanderbilt at Hyde-Park-on-Hudson. The stone arch here shown was also built by Mr. Vanderbilt at the same place. It crosses Crum Elbow Creek and has a clear span of 70 ft. with a rise of only 7 ft. 6 ins.; the width of the roadway is 24 ft., and the arch is 28 ft. wide over all. The bridge carries the old New York and Albany Post Road, now a public highway running through the Vanderbilt estate.

The bridge abutments rest upon rock, and while the spandrel facing is stone the interior work is Portland cement concrete. The ring-stones, 68 in number, and one key on each side, are 2 ft. 6 ins. high and 1 ft. and 1 ft. 6 ins. deep set alternately. These rings were put in place dry on the centers and separated by ¼-in. pine wedges. They were then pointed on the face and back, and finally grouted with a mixture of equal parts of Portland cement and sand, churned into the joint with a thin hoop iron. The sheeting stones of the arch were also laid dry, separated by ⅝-in. pine wedges, and after every five or six courses were set, Portland cement grout was poured into the joints, as for the face work. The lagging for the falsework, 2 × 4-in. hemlock, was laid so close that little of the grout escaped; and a hard, smooth intrados was formed. "Knickerbocker" Portland cement was used throughout.

This bridge was designed by Mr. O. Morris and built by Mr. D. Cuozzo, 39 Sherman St., Brooklyn, N. Y., general contractor, for a total sum of about $12,500. Of this sum Mr. Vanderbilt paid all except $2,700 contributed by the town. The bridge removed to give place to the present handsome structure was an old-time wooden King-post truss bridge of three 20-ft. spans. We are indebted to Mr. Cuozzo for the photograph and data used in the preparation of this article.

STONE ARCH BRIDGE ON THE ESTATE OF MR. F. W. VANDERBILT, AT HYDE-PARK-ON-HUDSON.

O. Morris, Engineer. D. Cuozzo, Contractor.

THE VALUATION OF COALS.*

By N. W. Lord.†

The application of chemical analysis to the economic valuation of coals, so that it can furnish a guide to the consumer in the purchase of fuel, is hardly to be considered as in a satisfactory state of development. Many hundreds of "proximate" analyses of the various coals have been published by the State Geological surveys, as well as by others, and several attempts have been made to generalize these results, so as to arrive at workable formulas by which given samples of coal could be valued and their actual performance predicted, but the results, so far, do not seem to have met any general acceptance.

The subject is one to which the writer has had to give considerable attention, and it is the object of the present paper to present and discuss a number of unpublished tests and analytical results which have been collected from various sources.

*A paper presented in Section C, Chemistry, of the American Association for the Advancement of Science, Boston meeting, Aug., 1898.

†Professor of Metallurgy in the Ohio State University, Columbus, O.

TABLE I.—Analyses of Jackson, Ohio, Coal.

Sample.	Carbon.	Hydrogen.	Oxygen.	Nitrogen.	Sulphur.	Ash.	Moisture.	Volatile combustible.	Fixed Carbon.	Calorimeter Result.	Calorific power calculated from ultimate analysis.	Difference per cent.	Cal. power calc. from "H."	Diff. per cent.
1 Center	70.05	5.43	17.09	1.49	1.84	4.10	8.26	35.15	52.49	6,854	6,835	— .3	6,844	— .1
3 North	71.20	5.50	17.71	1.45	0.76	3.38	8.45	34.09	54.09	6,937	6,890	— .7	6,949	+ .2
4 South	70,12	5.49	16.96	1.50	1.45	4.48	7.02	37.66	50.82	6,956	6,860	—1.3	6,935	— .3
5 West	71.42	5.37	19.49	1.43	0.64	1.65	8.65	34.30	55.40	6,981	6,795	—2.7	7,077	+1.4
6 East	70.79	5.55	18.60	1.46	0.95	2.65	8.50	37.75	51.10	7,069	6,854	—3.1	6,992	—1.1
Average	70.72	5.47	17.97	1.47	1.13	3.25	8.17	35.79	52.78	6,953	....	....	....	....

$$\text{"H"} = \frac{6934}{0.8745} = 7929.$$

Note.—"H" equals the average of the calorimeter results minus 22.5 times the average per cent. of sulphur, the remainder multiplied by 100 and divided by 100 minus the sum of the average percentages of ash, sulphur and moisture. It stands for the average heating power of the combustible portion of the coal less the heat due to the combustion of the sulphur. The calculation of the heating power of any sample from a seam, when "H" is known, consists in multiplying "H" by 100 minus the ash, moisture and sulphur (in per cents.), dividing by 100 and adding 22.5 times the per cent. of sulphur.

The starting point in determining the value of any fuel for any purpose is, of course, its calorific power or "absolute heating power." This has been for so long a commonplace that it seems singular that only recently has the determination of this fundamental constant been required of chemists by the mechanical engineers. The calculation of the heating power from the ultimate analysis was so long considered inaccurate to a degree precluding its use in valuing fuels that possibly on this account ultimate analyses of coals were rarely made in this country. The difficulties in the way of an accurate ultimate analysis are also well known. At any rate it is a fact that many such results from reliable sources are not to be obtained for American coals.

In a paper by the writer, in connection with Mr. F. Haas, published in 1897 (Trans. Am. Inst. Mining Engineers, and Eng. News, March 25, 1897), there were given a number of ultimate analyses and calorimeter determinations which tended to show that the calorific value of the coal from a given bed was nearly constant over considerable areas of the seam, provided the observed value on any sample was reduced to an ash, sulphur, and moisture free, basis.

Since the publication of the results referred to the Jackson coal, another prominent Ohio seam has been investigated. This furnishes a large amount of first rate coal to the Ohio markets. The bed covers a considerable portion of Jackson county. Samples were obtained from mines opened in the eastern, western, northern, southern, and central portions of the field. The samples were carefully taken by Mr. Laviers, engineer of the Superior Coal Co., and a former student of the writer's. The samples were from large amounts, and were intended to represent the average composition of the coal as mined at the selected points. The ultimate analyses and the calorimeter determinations were then made in the laboratory of the department of metallurgy by my assistant, Mr. Haas. The results are given in Table I.

The results shown appear fully to support the conclusions drawn in the former paper, that the heating value of the coal is practically constant throughout the bed. The failure of the last two samples to show close correspondence between the calculated values by Dulong's formula and the calorimeter results is contrary to our experience with other coals. These last two analyses are the average of duplicates which do not agree very satisfactorily, and, therefore, the results are a little open to question, as I fear some carbon may have escaped combustion. The other analyses given in the table are the average of very closely agreeing duplicates.

If the conclusion as to the comparative constancy of the heating value of the coal in any given seam is correct, then the determination of the heating power for any particular sample from the seam becomes a simple matter, if the ash, sulphur and moisture in the sample be known, and the seam constant for the kind of coal be known.

The substitution of complete sets of determinations of the ultimate composition and heating values of the coals in the different seams of a state for the present mass of proximate analyses of scattered samples would do much to clear the subject of coal valuations of its uncertainties.†

The main point at issue, however, is the relation between the calorific power of the fuel and its industrial value and how far this can be determined by chemical methods. With a view to getting more light on the subject, the writer has collected a considerable number of results of actual boiler tests made on the coals of the seams which have been examined in the laboratory of the department. These results have been furnished the writer by various persons in private communications. For commercial reasons the names of these furnishing the results cannot usually be given, but all the results are from large consumers of coal, thoroughly competent to judge of the care with which these tests were made. A number of the results are from tests made by Professor Hitchcock, of the Department of Mechanical Engineering of the Ohio State University, who has kindly furnished me with the evaporation figures be obtained. In the tests made by Professor Hitchcock most of the chemical and calorimeter work was done by Mr. Haas, my assistant, in the department of metallurgy, to whose industry, accuracy, and enthusiasm I am indebted for many of the results herewith presented.

The accompanying table gives the evaporation tests, together with the refuse or ashes determined practically from the weights of the material collected in the ash pits, as reported by those furnishing the tests. The percentage of unburned coal as given in the table is estimated in most cases by proportion from the percentage of ash found in the ash pit refuse and percentage of ash in the analysis of the coal. In other cases it is calculated by deducting from the per cent. of ash pit refuse the per cent. of ash found in the analysis of the coal.

All the analyses were made in the laboratories of the department, and of samples taken from the coal used in the boiler tests.

The evaporation results given in Table II. were obtained from different types of boilers and grates and by different observers, and hence cannot be taken as giving the comparative values of the different samples of coal tested, but in the aggregate they represent a varied experience in the use of coals of the same character for the purpose of steam raising.*

The evaporation figure given by a single test in any given boiler and furnace is of course dependent upon a number of factors, only one of which is the absolute heating power of the coal. This will account for the wide variation shown in the results obtained from coals of nearly the same heating power and of the same seam. Thus Hocking coal gives evaporations varying from 6.22

† It is interesting to note that the heating value of these five coals may be calculated from their average heating value per pound of combustible and from their approximate analysis, with as close an approximation to accuracy as is obtained by Prof. Lord's method of using the "H" value and the ultimate analysis. To show this we have made the following calculations.—Ed. Eng. News.

Average Heating Value per lb. Combustible = 6,953 ÷ (35.79 +52.78) = 7,850 Calories, Jackson, Ohio, Coal.

Coal No.	Volatile matter.	Fixed carbon.	Total combustible.	Calculated heating value.*	Calorimeter results.	Diff. %
1	35.15	52.49	87.64	6,880	6,854	+0.4
2	34.09	54.09	88.18	6,922	6,937	—0.2
3	37.66	50.82	88.48	6,945	6,956	—0.2
4	34.30	55.40	89.70	7,041	6,981	+0.9
5	37.75	51.10	88.85	6,977	7,069	—1.3

*Equals total combustible × 7,850 ÷ 100.

*The average results obtained in the boiler tests appear to be rather low. We have calculated the average "efficiencies," and find them as follows: Pocahontas, 62.4%; Hocking, 58.4%; Thacker, 58.1%; Upper Freeport, 55.0%; Darlington, 50.2%; Pittsburg, 56.6%. These figures do not include the tests of locomotive boilers. The best result from Hocking coal, 8.72 lbs., corresponds to an efficiency of 70.8%.—Ed. Eng. News.

TABLE II.—Boiler Tests with Various Coals.

Pocahontas Coal.

No.	Water evaporated from and at 212° F. per lb.	Refuse %	Ash by analysis. %	Coal unburned. %	Moisture. %	Calorific power. h. u.	Kind of boiler.
1..	9.94	11.8	7.92	3.9	0.77	7,988	Water tube, s
2..	9.29	5.94	6.99	3.0	0.61	8,080	" h
3..	8.37	8.26	5.63	2.5	0.63	8,185	" h
4..	8.04	8.88	5.81	4.6	..	....	Multitubular
5..	7.73	14.61	5.81	5.7	..	....	"
6..	10.66	..	3.83	0.2	..	8,409	Water tube, s
7..	10.89	..	6.05	0.3	..	....	" s
Av..	9.28	..	6.01	2.9	..	8,140	......
			Hocking Coal.				
8..	7.72	13.83	10.59	6.7	6.50	6,499	Water tube, s
9..	6.23	6.97	9.10	3.2	6.45	6,603	" h
10..	6.06	6.38	..	..	6.72	6,882	" h
11..	6.52	6.38	8.50	2.3	6.40	6,610	" h
12..	7.34	9.76	7.48	3.3	..	....	Multitubular
13..	7.15	11.32	7.48	3.3	..	....	"
14..	7.72	4.36	4.32	2.7	..	....	"
15..	8.72	..	9.37	0.7	6.68	6,616	Water tube, h
16..	8.00	..	12.85	0.9	6.00	6,482	" h
17..	7.45	..	16.95	8.5	7.55	6,089	" s
18..	6.52	..	12.95	5.0	6.20	6,454	" s
19..	6.22	..	12.45	4.1	6.10	6,569	" s
20..	6.78	..	14.85	8.5	6.13	6,458	" s
Av..	7.11	..	10.55	4.1	..	6,526	......
			Thacker Coal.				
21..	9.37	12.77	7.25	7.10	1.27	7,789	Water tube, s
22..	8.79	12.15	..	..	..	....	" s
23..	7.55	5.68	6.50	2.3	1.40	7,768	" h
24..	7.39	6.44	7.50	2.5	1.60	7,738	" h
25..	8.59	..	7.87	7.8	1.56	7,587	" s
Av..	8.36	..	7.28	4.9	..	7,720	......

Upper Freeport Coal.

No.	Water evaporated from and at 212° F. per lb.	Refuse. %	Ash by analysis.	Coal unburned. %	Calorimeter value.	Kind of boiler.
26.......	7.27	17.34	11.89	5.4	....	Stationary
27.......	7.41	16.48	9.58	6.9	....	"
28.......	7.62	14.30	7.82	6.5	....	"
29.......	7.65	11.54	9.17	2.3	....	"
30.......	7.84	12.70	7.66	5.0	....	"
31.......	7.42	14.08	9.42	4.7	....	"
Average..	7.53	..	9.26	5.1	7,326	......
32.......	6.45	..	9.10	..	7,326	Locomotive
33.......	7.11	..	8.10	..	....	"
34.......	6.54	..	10.45	..	....	"
35.......	6.72	..	8.70	..	....	"
36.......	6.23	..	8.25	..	....	"
Average..	6.61	..	8.92	..	7,212	......
			Darlington Coal, Pennsylvania.			
37.......	7.26	14.39	4.35	10.0	....	Stationary
38.......	7.34	14.16	8.75	5.4	....	"
39.......	7.62	12.22	4.95	7.3	....	"
40.......	7.51	14.98	6.65	8.3	....	"
Average..	7.43	..	6.18	7.7	7,652	......
41.......	7.15	..	8.70	..	....	Locomotive
42.......	6.47	..	8.80	..	....	"
43.......	6.04	..	8.05	..	....	"
Average..	6.55	..	8.52	..	7,283	......
			Pittsburg Coal.			
44.......	8.00	11.52	5.93	5.6	....	Stationary
45.......	8.43	11.82	7.95	3.9	....	"
46.......	7.89	11.60	6.08	5.5	....	"
47.......	7.83	12.55	9.25	3.3	....	"
48.......	7.88	11.57	8.86	2.7	....	"
Average..	8.01	..	8.01	4.2	7,596	......
49.......	8.12	..	9.05	..	....	Locomotive
50.......	7.66	..	9.05	..	....	"
Average..	7.89	..	9.05	..	7,374	......

s = mechanical stoker; h = hand-fired.

up to 8.72, the corresponding calorific values being 6,616 and 6,569, a difference of evaporation of nearly 30% and a difference in calorific power of less than 1%. These two tests were made in Columbus, and I am able to present the complete "heat balance" as computed for the test by Mr. Haas from his observations of the flue temperature, composition of the flue gas, analysis of refuse, etc. The tests which gave 8.72 lbs. evaporated was made on "run of mine" coal in a hand-fired furnace. The flue gas was analyzed every 30 minutes and the flue temperature read at the same time. The coal and refuse were carefully sampled and analyzed. The average flue temperature over that of the outside air was 244° C., the average excess of air in the flue gas 71% of that required for complete combustion. The heat distribution was as follows:

	Calories.	Per cent.
In products of combustion..............	563	8.5
In excess of air in flue gas..............	348	5.3
In latent heat in flue gas..............	276	4.2
In unburned coal	47	0.7
In evaporation	4,683	70.8
In radiation, etc. (by difference)......	699	10.5
Calorimeter test (by bomb)..........	6,616	100.

The test which gave 6.22 lbs. evaporation was made on "pea and slack" coal fired by a mechanical stoker. The flue temperature in excess of the external air was 274° C., and the average air excess in the flue gas was 281%. The gas analyses were made every 15 minutes by the Orsat apparatus. The heat distribution was as follows:

	Calories.	Per cent.
In products of combustion..............	633	9.6
In excess of air in flue gas..............	1,542	23.5
In latent heat in flue gas..............	2,259	3.9
In unburned coal	204	3.1
In evaporation	3,340	50.8
In radiation, etc. (by difference)......	591	9.1
Calorimeter test (by bomb)..........	6,560	100.

Another sample of coal in the same boiler as the last test gave 6.52 lbs. evaporated. Test made on pea and slack Hocking coal. Average flue temperature over external air 265° C., average air excess 205%:

	Calories.	Per cent.
In products of combustion	604	9.3
In excess of air in flue gas..............	1,069	16.5
In latent heat in flue gas..............	265	4.1
In unburned coal	308	4.8
In evaporation	3,501	54.2
In radiation, etc. (by difference)	707	10.9
Calorimeter test (by bomb)..........	6,454	100.

Samples like the above could be given of numerous other tests. The facts illustrated are, however, well known to all who have worked in connection with boiler tests. To the boiler maker or user the chemical analysis of the coal and its calorific value are of vital importance, as they enable him to construct just such a heat balance as above quoted, and to judge from this the performance of the boiler. The recent report of the committee on boiler tests to the Society of Mechanical Engineers dwells fully on the importance of this work.

Only the ultimate analysis of the coal will serve the purpose. Fortunately the ultimate analysis calculated from the average analysis of the seam can be used with little error if applied to the special coal samples with due correction for moisture, ash and sulphur in the sample tested. Boiler tests are expensive and demand mechanical engineers as well as chemists. The simple evaporation test without the heat balance gives no proper valuation of the single coal sample itself, as the figures quoted clearly show. How far can chemical analysis alone be used in predicting the boiler test, as it were? This resolves itself into an examination of how far the well-known formulas and methods for computing heating effects and losses can be depended upon. The consideration of any heat balance such as those quoted shows that besides the useful or available portion of the heat, there are two classes of heat losses. First, those dependent on the coal, and second, those dependent upon the grate, the style and condition of the boiler and the skill of the fireman. The second of these is not a matter determinable by the chemist from the analysis of the coal. By the general principle of averages, losses of this kind should tend to equalize themselves when a considerable number of results on the same coal are united, thus by taking the average of a series of evaporation tests a result should be obtained which would give a difference between the heat used in evaporation and the total heat developed that could be divided into two parts, one varying with the kind of coal, and the other more or less constant and independent of the kind of coal. This latter loss could be included in the valuation of the coal in one of two ways, either by subtracting a value for it as found from the average coal burned or by subtracting the value for it found in what might be considered the best tests. It would seem that the latter plan would be the more desirable, as it would tend to value the coal at an attainable figure, and yet one which would serve as a guide to the user and furnish a check on the performance of his grate and boiler. If a standard set of conditions in this regard be assumed it is obvious that all coals would be graded by them fairly.

The losses dependent upon the composition and character of the coal can be easily computed by well-known formulas. They comprise the heat latent in the products of combustion in water vapor, and the sensible heat in the product of combustion. The heat in the air excess, if the latter is measured in percentages of the air required to burn the coal, is to a certain extent dependent upon the composition of the coal for its computation and expression. One loss, varying with the coal as well as the grates, will be the percentage of unburned coal, which more or less depends on the friability, coking power and mechanical condition of the coal. The relation of this to the mode of combustion is, however, much closer than it is to the character of the coal, as is easily seen by reference to the results quoted in the table. The results for Pittsburg coal and for the Hocking coal are in the averages about the same, while the variation in each coal, according to the grate used, is very large. One of these is, as is well known, a strongly coking coal, and the other a typically non-coking coal. This factor in the valuation of the coal is best estimated from an analysis of the refuse from grates burning the coal. A simple estimation of the ash or non-combustible portion of the refuse is all that is needed. This assumes that the unburned portion is coal and not coke, which is probably only partially true. The error caused by assuming it to be pure carbon would in any case be but trifling. Numerous analyses have been made in our laboratory, which show that the unburned coal in the refuse is to a considerable extent uncoked. For example:

Refuse from Ash Pit.

	Thacker coal.	Pocahontas.	Hocking.
Moisture	0.15	0.40	0.83
Volatile	3.37	4.50	7.25
Fixed carbon	29.96	32.50	33.27
Ash	64.00	62.60	58.65

The figures for the Thacker coal are the average of two analyses. It will be seen that the volatile matter is considerable though not equal to what it would be in the coals. The radiation and other losses determined by difference in the boiler tests are somewhat variable. The writer has been in the habit of assuming this amount at 10% of the calorific power of the coal. This assumption is, of course, arbitrary, but a number of boiler tests made at the University give results approximating quite closely to this figure. If this correction be applied to the common formulas used in heat calculations, we would have for the relative practical heating value of the coal, or what might be called the "available heating power," the following:

"Available heating power" = 9-10 calorific power—latent heat—T (into water equivalent of products of combustion added to water equivalent of excess of air).

The evaporating power would be equal to the available heating power multiplied by 1 minus the fraction of unburned coal, and divided by 537. The air excess is easily determined from the flue gas analysis. If this analysis is expressed in parts by weight then the ratio of the air excess, that is, the air present in the gas, divided by the air used in the combustion of the fuel almost exactly equals $\frac{O}{3\text{-}10\,N - O}$. Let A stand for the ratio of the air excess and insert the values of the specific heats and let C H S and O stand for carbon, hydrogen, sulphur and oxygen, shown in the ultimate analysis of the coal, and we have the following formula:

Available Heat = 0.9 calorific power — 9 H × 589. — T° carbon (11/3 × 0.217 + 8/3 × 3.33 × 0.244 + 8/3 A × 4.33 × 0.237) — T° H × 9 × 0.48 — T° (H — 1/8 O) (8 × 3.33 × 0.244 + 8 × 4.33 × 0.237 A) — T° sulph. × (2 × 0.154 + 3.33 × 0.244 + 4.33 × 0.237 A). This reduces to

Available Heat = 0.9 calorific power — 5,301 H — T° C (2.963 + 2.738 A) — T° H × 4.32 — T° (H — 1/8 O) (6.498 + 8.209 A) — T° S (1.121 + 1.027 A).

Of course this is only text-book work, but where the values of A and T are determined by experiment and the value of the coal unburned by analysis of the refuse, the above expression will give the evaporation shown by the coal within a reasonably close figure, as the writer has verified repeatedly. Where the C O forms a noticeable percentage of the gas the results will be unreliable. This condition is on the whole uncommon, and is usually associated with a small air excess, and is obviously wasteful of coal. In the records of many flue gas analyses in the department of metallurgy, few show more than fractions of a per cent. of C O present. The grading of coals generally by any such formula will, however, depend upon the assumption of standard values for A and T. In order to apply it to the boiler tests given in the table, I have assumed, for purpose of comparison, A equal to 1 (or 100% of air in excess of that required to burn the coal), and T equal to 200°C., as representing a fairly attainable figure in good practice. If these conditions be introduced into the above formula it takes the following form, provided the sulphur is omitted as unimportant, in such a formula only intended for practical results:

$$\text{Evaporated power} = \frac{1}{537}\,(9/10 \text{ cal. P} - 9{,}106\text{ H} - 1{,}140\text{ C} + 377\text{ Ox}).$$

Applying this to the average results on the coals tested, the average composition of the Pocahontas coal, as shown by analyses previously published, is as follows: C, 84.87; H, 4.29; O, 3.51; N, 0.85; S, 0.59; Ash, 5.89.

By the assumed formula this would give an evaporating power of 11.2, assuming the coal all burned. The average unburned coal of the test is 2.9%. Correcting for this, there remains an evaporative efficiency under the assumed conditions of 10.9 lbs. The average of the tests is 9.28. The best test is 10.89.

The average composition of the Hocking coal as given in the paper previously quoted is: C, 68.03; H, 5.29; O, 15.64; N, 1.44; S, 1.59; Ash, 8.00. The formula gives for its evaporative value under standard conditions, 8.9 lbs., or allowing for the average unburned coal, 8.6 lbs. The best result of the test is 8.72. The average is 7.11. In the same way the Thacker coal, having the ultimate composition: C, 78.65; H, 5.17; O, 7.22; N, 1.17; S, 1.28; Ash, 6.27; gives for its evaporative efficiency 10.5. Correcting for the average ash leaves 10 lbs. The maximum value in the test is 9.37. The average is 8.36. The number of tests on this coal is noticeably less than on the others. The average composition of the upper Freeport coal is: C, 72.65; H, 5.06; O, 8.95; N, 1.34; S, 2.89; Ash, 9.10. This corresponds to a standard of evaporation of 9.9 lbs., or, correcting for average unburned coal on the six tests made in stationary boilers, 9.4 lbs. The average evaporation is 7.53 in the stationary boilers. The locomotive tests are much below the others, averaging 6.61 lbs.

The Darlington coal, with the average composition of

C, 75.19; H, 5.14; O, 9.05; N, 1.46; S, 1.98; Ash, 7.18; computed in the same way, gives 10.2 lbs. evaporated, which, corrected for the average unburned coal, becomes 9.4 nearly. The average evaporation in stationary boilers is 7.43; in locomotive boilers, 6.55 lbs.

The Pittsburg coal has for average composition: C, 75.24; H, 5.18; O, 8.24; N, 1.51; S, 1.79; Ash, 8.00. This gives for evaporation, under assumed standard conditions, 10.2, or, correcting for average unburned coal, 9.8 lbs. The average evaporation in stationary boilers is 8.01, and in locomotives 7.89. In the locomotive tests quoted no figures were furnished me for the amount of refuse. Losses through grates and stack in the locomotives must be a large factor in the case of the more friable coals. If we unite together these computed standard evaporations of the different coals with the actual as shown in the averages of the boiler tests, we have the following table:

Coal.	Calculated evaporation.	Average actual.	Difference.
Pocahontas	10.9	9.28	1.68
Hocking	8.6	7.11	1.49
Thacker	10.0	8.36	1.64
Upper Freeport	9.4	7.53	1.87
Darlington	9.4	7.43	1.97
Pittsburg	9.8	8.01	1.79

The average difference between the calculated values and the actual evaporations is 1.73 lbs., showing that the average duty of the coals is about 1¾ lbs. less than would be given under the standard conditions.

The relative values of the coals, as rated by the results of the boiler tests by the calculated values, and by the average calorimeter results, is shown in the following table; the Hocking coal is assumed as having a value of 100, and the others compared with it by dividing each result by the corresponding result for Hocking coal:

Relative Values of Coal. (Hocking Coal = 100.)

Coal.	By calorimeter.	Boiler test.	Calculated evapratn.
Hocking	100	100	100
Pocahontas	122	127	131
Thacker	116	117	116
Freeport	109	106	109
Darlington	112	105	109
Pittsburg	113	113	114

This table shows that a coal like Pocahontas, high in carbon and low in hydrogen, gives higher evaporation duty in proportion to its calorimeter value than those coals higher in hydrogen and oxygen, as was, of course, to be expected. The foregoing results are not sufficiently numerous to serve as more than indications, but as far as they go they show that the valuation of coal by the calorimeter and ultimate analysis gives results of importance which would serve as a useful guide in selecting fuels for steam raising. Furthermore, they show that calculations based on the averages for the seam, when such analyses are obtained by the analysis of carefully prepared samples, can be depended upon in rating the relative values of coals to the consumer.

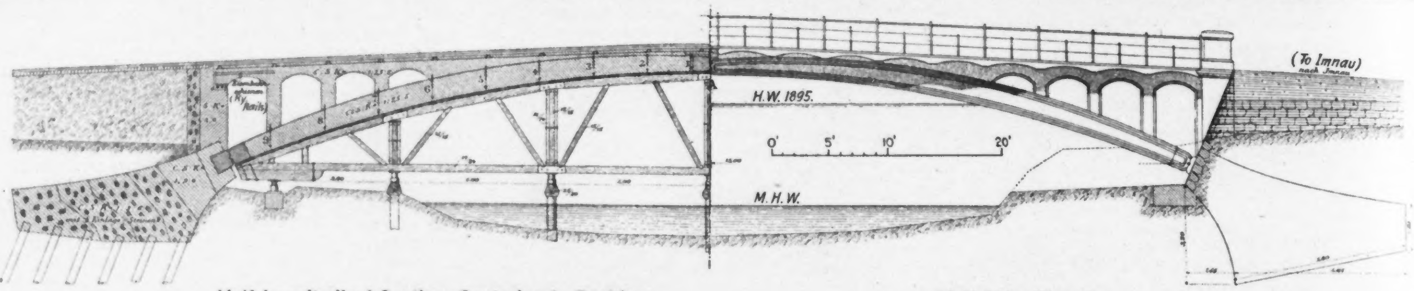
I have not attempted here to apply these calculations to the individual results. Close correspondence in the special cases is not to be expected for reasons previously shown, but the conclusions drawn from the average results are offered as testifying to the reliability of well-known methods of heat calculations and as an argument for the more general introduction of ultimate analysis on the valuation of coals. It would appear especially desirable that public surveys of coal fields should adopt this method of analysis. The results further suggest that coal users should realize more fully that coals can be valued by analysis, and that it is important that their boilers and grates be held responsible for failure to approximate the chemical valuation.

A CONCRETE ARCH BRIDGE WITH GRANITE HINGES.

While both iron and lead have been used as hinges in arch bridges, the iron hinge is expensive, and the break in the massive arch caused by its insertion has been objected to from an aesthetical point of view. This latter consideration especially induced Mr. Max Leibbrand to adopt stone hinges for a bridge of 30 m., or 98.43 ft. span, across the river Eyach, near Imnau, Hohenzollern.

As from the construction these hinges would be subjected to severe bending and other strains, granite was adopted, after a number of tests of various kinds of stone to determine their resistance and elasticity. To insure the proper distribution of strains on the hinge, and to act as a lubricant, thin layers of lead were introduced between the polished surfaces of the hinge-segments. The following description of the Imnau bridge is condensed from an article published in the "Zeitschrift fur Bauwesen" and written by Chief Engineer Alfred Gaedertz, acting under Mr. Max Leibbrand, the State official in charge.

The Imnau arch is built to replace a structure destroyed by a flood in 1895; and to guard as much as possible against a repetition of the disaster, a single span was decided upon. Although the foundation conditions were not the most favorable for arch construction, a comparison of cost made between a concrete arch and an iron truss bridge favored the former. The conditions required that the vertical pressure, or load, on the foundations should be large, as compared with the horizontal components; and this was accomplished by concentrating the dead weight at the ends of the bridge; by applying the live load as near the center as possible, and by introducing hinges which would, to a certain extent, compensate for any possible future movement in the abutments.



Half-Longitudinal Section, Centering in Position. Half-Side Elevation.

FIG. 1.—HALF-SECTION AND HALF-ELEVATION OF IMNAU ARCH.

Owing to a limited appropriation, the width of the bridge was only 4 m., or 13.12 ft., the roadway being 8.20 ft. wide, with two sidewalks of 2.46 ft. each. These sidewalke are supported on flat concrete arches, projecting outside the faces of the arch, and laid between beams spaced 5.6 ft. apart. The arch proper is only as wide as the roadway at the center, or 8.20 ft., but it spreads to 11.48 ft. in width at the springing lines. This feature of construction not only moves the center of gravity of the mass nearer to the abutments, but it also renders the arch more stable against wind pressure, flood and ice. The roadway, where it does not rest directly on the arch, is supported by piers 1.64 ft. wide, carrying secondary arches of 3.94 ft. span.

On the left bank the concrete abutment is more than twice the width of the arch at the center, and is supported by 41 piles, about 10 ins. diameter and 13 ft. long; the right abutment rests immediately on sand. As the soil is not capable of sustaining any concentrated heavy load, the areas of these foundations were so arranged that the maximum load on the sand was 4,500 lbs. per sq. ft. and that on each pile was 16.5 tons.

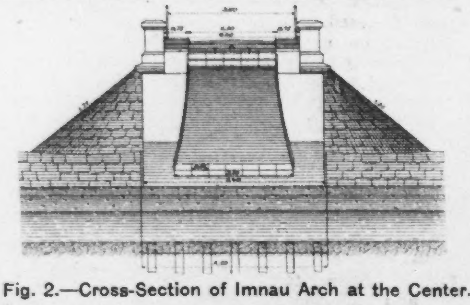


Fig. 2.—Cross-Section of Imnau Arch at the Center.

The hinges at the abutments and at the crown of the arch were made of granite blocks, each 1.64 ft. wide, measured vertically to the face of the arch. The bridge was cylindrical in form, about 4 ins. diameter, and the whole contact surface was polished and covered with a lead plate 3-16-in. thick; a thin copper plate was inserted between the lead and the stone to prevent the penetration of the lead into the latter under pressure. The opposing hinge segments were securely clamped together after the lead was in place and the clamps were not removed until the centers had been struck.

The span of the arch between centers of abutment hinges is 30 m., or 98.43 ft.; the versed sine is 3 m., or 9.84 ft.; the depth of the arch at the crown is 1.48 ft.; at the springing joints it is 1.64 ft., and at the haunches, 262 ft. As before indicated, the depth of contact at the hinges is only 4 ins. This arch is designed to carry a crowd of people, equivalent to a distributed load of 74 lbs. per sq. ft., and a steam road-roller, weighing 16½ tons. It is figured that under this loading the compressive strains will not exceed 483 lbs. per sq. in., and the maximum tensile strain will be 57 lbs. per sq. in.

The faces of the bridge are finished in an imitation of granite, to conform with the granite hinges and to avoid the efflorescence so common in concrete work. This granite facing was made of one part cement to five parts of broken Jura limestone; it was applied simultaneously with the other concrete in a layer about 4 ins. thick; and after it had set for 12 hours the loose cement was removed by water and brushes, and a broken, granite-like face produced.

This bridge was finished and the falseworks were removed on Sept. 15, 1896. A deflection at the crown, amounting to 19-32-in., was then observed; careful observations were made each day, and this deflection gradually increased until it was 1 3-16 ins. on Sept. 26. In this connection the author refers to the much greater additional settlement of the hinged arches at Inzigkofen and Munderkingen; and he remarks that in comparing the deflection of bridges of this type, we must consider not only the elasticity of the concrete and the influence of temperature, but also a certain further contraction in volume due to concentrated loading; to chemical action within the mass during the first period of settling, and to the evaporation of moisture. From Sept. 26 to Oct. 9, in this Imnau arch, no further deflection was observed, and the test load was then applied.

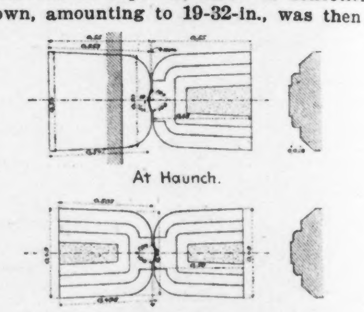


Fig. 3.—Detail of Granite Hinges of Imnau Arch.

In this test an empty horse-roller, weighing 3.86 tons, was placed at the center of this arch, and a deflection of 1-32-in. was observed then, a loaded horse-roller, with six horses, weighing in all 7.7 tons, caused a deflection of 3-64-in.; but in both cases the arch resumed its former position after the removal of the load. A uniform load of 20 tons was finally distributed on the middle two-thirds of the span, and this produced a deflection of 5-64 in.; this load was left on the bridge over night, and the next morning a deflection of 5-64-in. was noted. The loading was then increased to 33.1 tons, over a length of 88.6 ft. and somewhat concentrated at the center; this caused a deflection of 11-64-in. When this latter load was removed the arch rose 2-64-in., leaving a permanent deflection of 9-64-in. The author doubts the accuracy of these readings and thinks they were too large; and at the time of writing the total load figured upon had not been applied.

Including foundations the total mass of masonry in this bridge was 407.5 cu. yds. In the foundation a concrete mixture of 1, 3, 6 was used; that in the arch was 1, 2½, 5. Pure quartz sand was alone employed, and the cement was a slow-setting Portland; the broken stone was required to pass through a 1.6-in. ring. The cost of the foundation concrete was $3.20 per cu. yd., and in the arch it cost $8.24 per cu. yd. The whole arch was finished in 3¼ months, with the concrete work done in 1½ months; the arch proper was laid in 5 days. The contract price for the whole work, excepting approaches and bank protection, was $2,930; and the total cost, including superintendence, was $4,285.

The original paper details the tests applied to determine the resistance of the granite, under the different stresses, and also experiments with ordinary rolled lead sheets, under pressure and at various periods of time. It was originally intended to use lead sheets ⅛-in. thick; but the tests proving the difficulty of bringing plates of this thickness into perfect contact, 3-16-in. plates were finally adopted. The result of the series of tests, as made by Professors Bach and Toppi, were favorable to the use of granite hinges as a substitute for iron, even in larger spans than that of the Imnau arch.

THE BY-PASS CHANNEL FOR THE CHICAGO RIVER.

(With full-page plate.)

With the completion and opening of the Chicago Drainage Canal, a year or so hence, a flow of 300,000 cu. ft. of water from Lake Michigan to and through the canal will be required, and this will necessitate some changes in the Chicago River in order to increase its capacity. A general scheme of dredging is being carried out, and the widening works to be undertaken by the U. S. Government will also have an influence upon the work. The bed of the river is most irregular, and about three years ago Mr. Thos. T. Johnston, then Assistant Chief Engineer of the drainage canal, made a report recommending that from the Lake to Robey St. the river should have a depth of 12 ft. at the dock line, increasing to 20 ft. at a distance of 40 ft., this 20-ft. channel depth not to approach within 40 ft. of any dock line or bridge pier. This would require but little new dock construction.

There are certain parts, however, which call for special treatment, and the worst of these is the narrow stretch from above the Adams St. bridge to below the Van Buren St. bridge. The four adjacent bridges at Adams, Jackson and Van Buren Sts., are all single opening drawbridges, the first two being swing bridges, with their shore arms spanning made land occupied as railway yards, while the two bridges at Van Buren St. (one four-track railway bridge and one highway bridge) are bascule bridges of the Scherzer type. The bridges being so close together, and having very narrow openings, make this stretch of the river a limiting point of its capacity. Mr. Isham Randolph, the Chief Engineer of the drainage canal works, suggested some years ago the construction of a by-pass or conduit around the obstructions, on the west side of the river, at an estimated cost of about $250,000.

When the improvement of this section of the river again came up for consideration in 1897, it was at first proposed to undertake the work of widening the river on a bold scale, in order to facilitate navigation through this narrow stretch, as noted in an editorial in our issue of July 21, 1898. The general plan was to cut away a portion of the made land so as to reopen the channel on the west side of the pivot piers. The land, however, is occupied by the freight yards and freight houses of the Pennsylvania Lines and the Chicago & Alton R. R., which roads refused to allow any excavation, and an attempt to force the carrying out of this plan would have resulted in protracted and expensive litigation. The depth could not be increased on account of the tunnel north of the Van Buren St bridge, which carries the cable line of the West Chicago Street Ry. The plans for widening and deepening at this point were, therefore, abandoned, and after consultation between the representatives of the city authorities, the drainage trustees and the railway companies, it was decided that the necessary increase of capacity should be obtained by means of a by-pass or conduit built under the railway yards, and extending from above Adams St. to below Van Buren St., a distance of about 1,100 ft. The work was to be done by the drainage trustees, and the surface and traffic of the yard were not to be interfered with, except at certain points to allow of building the temporary work to carry the tracks during the construction of the by-pass. The trustees will also pay a small annual rental to the railway companies.

The general plan of the work is shown in Fig. 1. Two lines of masonry side walls will be built 50 ft. apart, and as the walls progress, the material between them will be taken out. Across the walls will be laid lines of girders, 10 ft. to 15 ft. apart, between which will be concrete arches. The work is now under way, but is being executed under difficulties, as the tracks and buildings must be left undisturbed, and the portions of the yard affected must, therefore, have a wooden flooring, supported on timber trestling over the excavation. The channel will be 50 ft. wide, excavated to a depth of 16 ft. below Chicago datum. It will be in two sections, respectively, about 300 ft. and 800 ft. long, or 1,100 ft. in all. The curved portion has radii of 192 ft. and 242 ft. on the faces of the walls.

At the Van Buren St. highway bridge a new approach span will be put in on the west side, to allow of the removal of part of the approach embankment where it crosses the line of the by-pass. Some sewers will be intersected, and these will discharge into the by-pass. The 5-ft. brick water tunnel of the Metropolitan Elevated Ry. will also be intersected, necessitating the construction of a new intake on the west side of the by-pass, beneath the Pennsylvania Lines freight house. The channel will also cross the roof of the West Chicago Street Ry. tunnel, which will be spanned by heavy girders, so that no load will be imposed upon the tunnel masonry. A portion of the existing piling, etc., which would obstruct the mouth of the by-pass will be removed. To carry the yard surface, piles are driven and capped, and upon the caps is a timber floor for the roadway and tracks. The work is carried on under this floor, the excavated material being run out on small iron cars on a narrow gage track. The cars are hoisted up by the boom of a travelling derrick, which then runs along to the cofferdam at the head of the work and dumps the material into scows. This derrick is of the Jackson type, made by Geo. D. Grannis, of Syracuse, N. Y.

The side walls, Fig. 2, will be of concrete, 4 ft. thick on top, increasing by 12-in. offsets to a bottom width of 6 ft. They will be capped with a Bedford stone coping 14 ins. thick. The foundations may consist of four rows of piles or a timber grillage. The latter plan will be largely, if not entirely, used, owing to conditions which almost prohibit the use of piles. The concrete is to be composed of 1 part of Portland cement, 3 parts of sand, and 6 parts of 1¼-in. broken stone, the mixture being made wet enough to have a quaking or liver-like consistency. The bottom of the wall will be 1 ft. below the bottom of the channel, or 17 ft. below Chicago datum (which is about 6 ins. above the level of water in the river.) The top of the coping will be 17 ft. above the bottom of the channel, or 1 ft. above datum. On each side of the railway tunnel, the walls will be enlarged, to form abutments for box girders spanning the tunnel and carrying the transverse roof girders. Across the tunnel will be light retaining walls 2 ft. thick on top and 4 ft. at the bottom, but these will not carry any load. The abutments will be 6 ft. wide on top and 8 ft. at the bottom. This arrangement is shown in Figs. 1 and 2.

The abutment of the new west approach span of the Van Buren St. bridge will be reinforced by two cylinder piers, 6 ft. in diameter outside, or 6 ft. 9 ins. over the flanges. The cylinders will be built up of cast-iron sections 8 ft. high, with outside flanges, the metal being 1½ ins. thick in the shell and 2 ins. in the flanges. Each joint will be put together with 32 bolts 1½ ins. diameter. Within the cylinder will be five piles, which may be driven before or after the placing of the cylinders. The soft material will then be removed by a water jet or suction pump, and the space filled in with Portland cement concrete. A 14-in. cap of Bedford stone will be set just within the top of the cylinder. The construction of the walls and piers is shown in Fig. 2.

The roof of the channel will be carried by transverse plate girders, with reinforced webs, most of which will be of the construction shown in Fig. 3, 55 ft. long and 49 ins. deep at the ends, where they rest upon cast-iron bed plates. They will be mainly 10 ft. apart. The web plates are 48 ins. deep, ½-in. thick for the middle panel (30 ft. long) and ¾-in. for the end panels (12 ft. 6 ins.). The web is reinforced by four side plates 12 ins. deep, these plates being ⅝-in. thick for the middle panel and ½-in. for the end panels. Outside of these are the four flange angles, ¾ × 8 × 8 ins., to which are riveted four cover plates at top and bottom. These plates are ⅝ × 20 ins., and one of each set extends the full length of the girder. The webs have triple rows of rivets at top and bottom, and the web splices are triple-riveted in each plate. On the curved portion of the channel, a line of facia girders will be fitted between the transverse girders, being almost tangent to the inner wall and extending from one end to the other of the outer wall as a chord line. Some of the roof girders have gusset plate stiffeners at their ends.

Fig. 4 shows one of the two box girders spanning the cable railway tunnel. These are 63 ft. long, 55 ft. 2 ins. apart, c. to c., and each consists of two plate girders, connected by diaphragm plates in line with the webs of the four transverse girders, which are 15 ft. apart. These latter are very similar to those shown in Fig. 3, but have longer cover plates. Their webs fit between vertical angles in the box girders, while their chords fit between plates projecting from the chords of the box girders.

The material used is to be soft steel, with ⅞-in. rivets driven in 15-16-in. holes, and the material and workmanship are required to conform to the standard specifications of the Pennsylvania Lines, except that reaming is not required. The material will be given a coat of boiled oil at the shops, with two coats of red lead for surfaces to be riveted up in contact. After erection, it will be given two coats of red lead paint. The first will be composed of 33 lbs. of lead (ground dry) to 1 gallon of raw linseed oil, and the second will consist of the same proportions, with the addition of 1 lb. of lampblack to each 5 gallons of oil.

Between the transverse girders will be arches of Portland cement concrete, which will entirely envelop the girders, giving a thickness of 3 ins. over and around the flanges. This construction is shown in Fig. 5. The arches of 15 ft. span, being under the roadway, will be only 12 ins. thick at the crown, with a radius of 9 ft. Above them will be 6 ins. of earth filling and an 8-in. granite block paving. The arches of 10 ft. span, being under the yard tracks, will be 15 ins. thick at the crown, the radius being 5 ft. 3 ins. In these arches, the upper surface of the concrete will be lower than the tops of the girders. Over the concrete arches will be 14 ins. of earth filling, upon which will be the 8-in. ties for the tracks. The concrete arches are to be composed of 1 part cement, 2 parts of sand and 5 parts of 1¼-in. broken stone, made wet enough to have a quaking or liver-like motion. The bottom flanges of the girders and other projections will have expanded metal attached, so as to form a lathing to hold the cement mortar, as shown by the dotted lines in Fig. 5. In order to prevent the stone in the concrete from coming in contact with the metal, all the metal-work will be plastered with a sufficient thickness of 2 to 1 cement mortar, composed of 100 lbs. of Portland cement to 2 cu. ft. of sand.

The contract for the substructure was let to the Lydon & Drews Co., of Chicago, and that for the substructure was let to Griffiths & McDermott, also of Chicago. The lists of bids were given in the supplements of our issues of June 23 and 30, 1898. The total cost of the work will be $175,000. The planning and execution of the work is under the supervision of Mr. Isham Randolph, Chief Engineer of the Chicago Sanitary District, to whom we are indebted for blue prints and specifications made use of in the preparation of this article.

NEW PASSENGER STATION AT QUINCY, ILL.; C., B. & Q. R. R.

Extensive terminal improvements at Quincy, Ill., are being carried out by the Chicago, Burlington & Quincy R. R., as described in our issue of March 17, 1898, and the work includes the construction of a new passenger station which is the subject of the present article.

The station is a one-story building, placed at the side of the track, and having a tall central tower as its conspicuous architectural feature. The building is 304 ft. long and 58 ft. wide. The walls are of red pressed brick, with trimmings of Berea limestone and red and variegated terra-cotta. The roof tiles are of green slate. The main portion is 22 ft. 4 ins. high at the top of the walls and 39 ft. 1 in. to the tile crest of the roof. The tower is 20 ft. square at the roof level, and rises to a height of nearly 150 ft. Fig. 1 is the city elevation, fronting upon Second St.

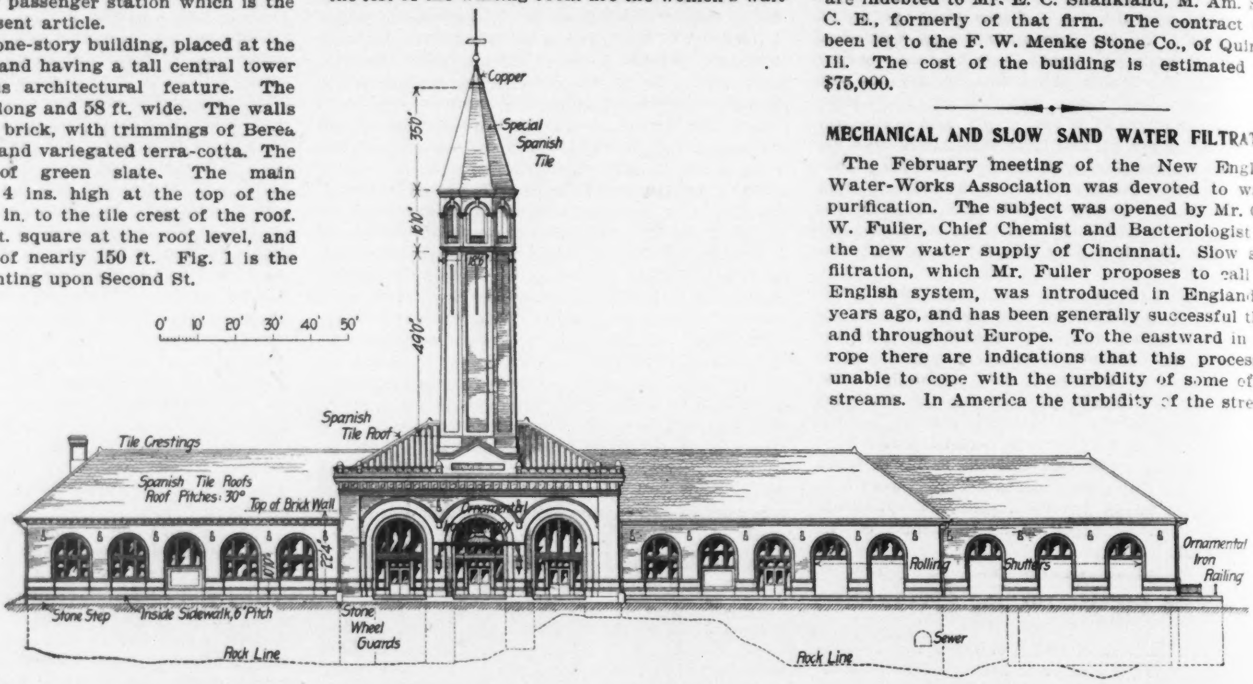


FIG. 1.—CITY ELEVATION OF THE NEW PASSENGER STATION AT QUINCY, ILL., C., B. & Q. R. R.
D. H. Burnham & Co., Architects.

The main waiting room, about 70 × 54 ft., is at the middle of the building, and forms the main thoroughfare from the street to the station platform, this arrangement being in accordance with the peculiar and almost universal practice of railway architects in this country. Nevertheless it is a very defective and inconvenient arrangement, and it is surprising that railway engineers and officials permit it to be so frequently used, as pointed out in the article on "The Design of Railway Stations," in our issue of Jan. 12. A portico in front of the waiting room extends over the cement sidewalk in front of the building, and has a light iron canopy to shelter passengers alighting from carriages. This portico has a groined ceiling, finished in mosaic. The waiting room has three sets of swinging doors at the portico, and another set opens upon the station platform, which is of wood.

To the right of the waiting room are the ticket office, telegraph office, conductors' room, smoking room and men's toilet room, with a corridor leading to the checking counter of the baggage room. Beyond this are the mail and express rooms, and an area with iron staircase to the basement. The boiler room is below the express room, with a smokestack on the track side of the building. To the left of the waiting room are the women's waiting and toilet rooms, news-stand and lunch room, with corridor leading to the restaurant and kitchen. The floors of the baggage, mail and express rooms are level with the platform, while in the other rooms the floors are about 18 ins. above the platform, which is reached by three steps. The platform will be covered by a shed roof.

The interior finish consists mainly of enameled brick wainscoting, with plastered walls and ceilings, the wainscot being omitted in the ticket and telegraph offices, conductors' room and kitchen. The corridors and baggage room have pressed brick walls, and the mail and express rooms have common brick walls, with plastered ceilings and cement floors. The waiting room has a marble tile floor, and the other rooms have mosaic tile floors, except that wood is used in the ticket office, conductors' room, telegraph office and kitchen. The openings in the walls of the baggage, mail and express offices are fitted with rolling steel shutters. The building will be heated on the direct steam system, and will be lighted by 750 incandescent lamps, the current for which will be generated by a plant at the railway company's roundhouse near the station.

The architects for the building are D. H. Burnham & Co., of Chicago, and for the plans we are indebted to Mr. E. C. Shankland, M. Am. Soc. C. E., formerly of that firm. The contract has been let to the F. W. Menke Stone Co., of Quincy, Ill. The cost of the building is estimated at $75,000.

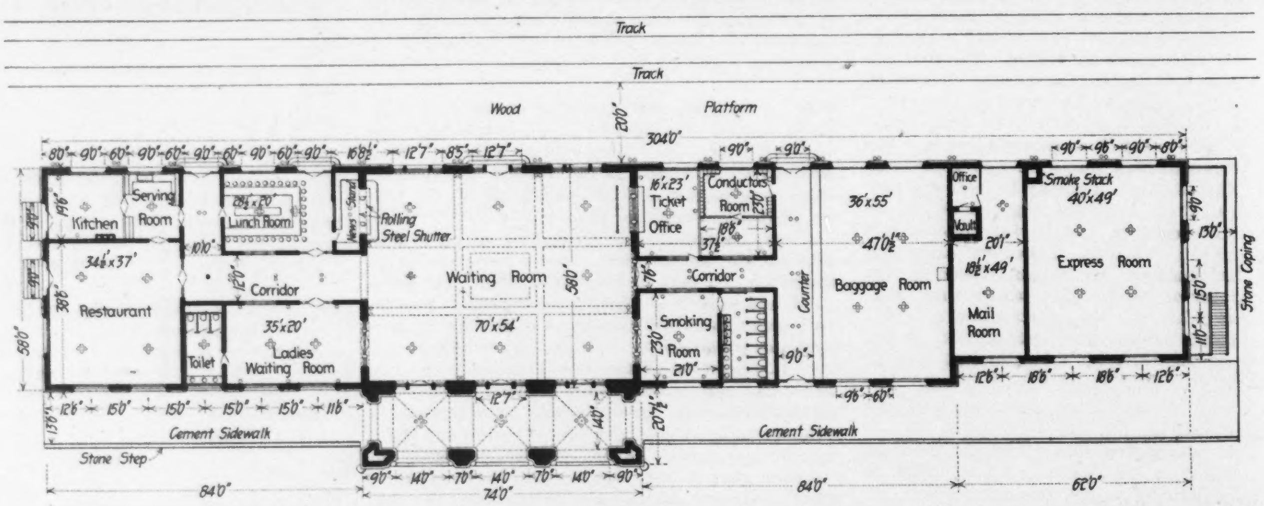


FIG. 2.—PLAN OF STATION AT QUINCY, ILL., C., B. & Q. R. R.

MECHANICAL AND SLOW SAND WATER FILTRATION

The February meeting of the New England Water-Works Association was devoted to water purification. The subject was opened by Mr. Geo. W. Fuller, Chief Chemist and Bacteriologist for the new water supply of Cincinnati. Slow sand filtration, which Mr. Fuller proposes to call the English system, was introduced in England 70 years ago, and has been generally successful there and throughout Europe. To the eastward in Europe there are indications that this process is unable to cope with the turbidity of some of the streams. In America the turbidity of the streams increases to the westward, and simple filtration becomes inadequate after leaving the comparatively clear waters of the East. In extreme cases the turbidity of Western waters is caused by clay particles 1-100,000 of an inch in diameter, or 0.1 the size of water bacteria. In slow sand filters, this clay gives rise to turbid effluents and penetrates the sand sometimes almost to the bottom of the bed, tending to change the character of the filtering material. At Cincinnati it was thought that the penetration of the clay was partly due to the absence of a layer of organic matter on the surface of the beds, and also to the absence of a film of it on the sand grains. The organic matter in the turbid water was so stable in composition that no nitrification took place with turbid waters. A modified system of slow sand filtration was therefore adopted, in which filtration was preceded by subsidence and coagulation.

Mechanical filtration was originally adopted to clarify water for industrial purposes. It is especially adapted to Western waters, both in point of efficiency and cost, while slow sand filtration seems more applicable in the East. Whether Eastern waters can be readily treated by mechanical filtration needs more study. Mechanical filtration requires less skill in operation than the other method. Future investigations will probably be chiefly to determine what modification of either slow sand or mechanical filtration are needed where neither of these systems alone is sufficient, rather than to aid in deciding between the two.

Efficient management is a prime essential to the successful operation of purification plants. It is absurd to spend large sums in construction and then place the works under inefficient management.

The next speaker was Mr. Allen Hazen, Assoc. M. Am. Soc. C. E., of New York. He said it has been known for a long time that slow sand filtration will remove bacteria and that mechanical filtration will remove turbidity. The effect of the latter process on bacteria has been a subject on which little has been known until recently. For clear Eastern waters sand filtration is preferable, and for turbid Western streams mechanical treatment may be necessary.

The average suspended matter in Eastern water may be taken at 1 part in 100,000, by weight, against 30 parts in the Ohio River water at Louisville. In flashy streams turbidity may sometimes increase 100 times in an hour. On small streams the period of turbidity is short and storage may be used to tide it over. On huge streams this is impracticable, since the turbidity will continue until the water from the most remote feeders passes the intake.

Generally speaking, the cost of sand filtration increases directly with the turbidity. For mere clarification mechanical filtration is the cheapest, but if high bacterial efficiency is desired, and for clear waters, slow sand filtration is the cheapest.

At Albany the gravel layers at the bottom of the filter beds is being replaced by sand for the 2 ft. nearest the walls. This is to insure filtration for any water that may come in through the cracks which almost always develop in the lower part of the masonry walls of filter beds. Mr. Hazen showed a number of lantern slides, comprising views of American and European filtration plants.

Mr. Desmond FitzGerald, President Am. Soc. C. E., also showed some lantern slides, chiefly of the two sets of filter beds built by the city of Boston, but now included in the Metropolitan Water System. The Pegan Brook beds were built to purify the water of a small feeder to Lake Cochituate (see Eng. News, June 28, 1894). Those at the Hopkinton reservoir were for removing color from the water stored in the reservoir. The latter are not now in use, as it has been considered unadvisable, since the Nashua supply became available, to draw water from the main part of the Sudbury River. Both sets of beds were built in a natural deposit of gravel, by throwing up enbankments. Mr. FitzGerald believes that many cities might improve their water supplies by such simple means as these.

A LARGE BLOOM SHEAR AND TURRET-HEAD PUNCH.

A monster shearing machine for steel blooms is being built for the Lorain Steel Co., of Lorain, O., as a companion to one put in a few years ago. The machine, of which a view is shown in Fig. 1, is 21 ft. high, and has a stroke of 10½ ins., being designed to cut blooms 10 x 10 ins., or 100 sq. ins. of metal at one stroke. The cylinder is 14 x 18 ins. An adjustable automatic hold-down prevents the piece from tipping up while being cut, and there is a gage for determining the length. It is mounted on a heavy bed-plate having grooves of octagonal section, and the journal stand is fitted to the same bed-plate. In this way the machine cannot get out of alinement, while it can readily be taken apart should that ever be necessary.

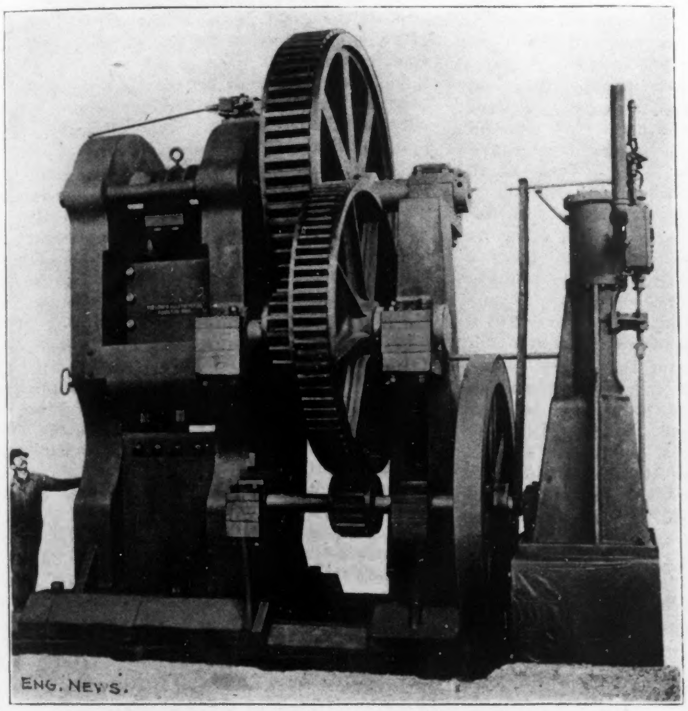


FIG. 1.—BLOOM SHEAR FOR CUTTING 100 SQ. INS. OF METAL.
The Long & Allstatter Co., Hamilton, O., Makers.

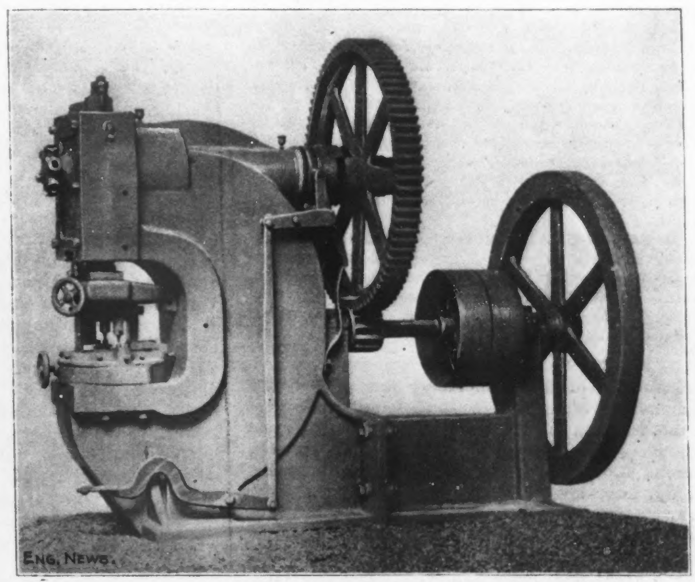


FIG. 2.— TURRET HEAD PUNCHING MACHINE.
The Long & Allstatter Co., Hamilton, O., Makers.

The total weight of the machine is about 250,000 lbs., each housing weighing over 54,000 lbs., and there being about 35,000 lbs. of steel casting, while the cam shaft which operates the slide weighs over 10,000 lbs. One machine is made right hand and the other left hand, so that the engines will stand facing each other, and one man can operate both machines.

A somewhat novel form of punching machine is shown in Fig. 2 having a turret-head constructed to carry four or more punches of different sizes and shapes with dies to suit. The block can be almost instantly rotated so as to bring any punch and die in proper line for doing the work. The design was made to facilitate the manufacture of parts for certain agricultural machinery and safes, so that by simply turning the turret head, four or five holes of different sizes can be punched in a bar or angle iron without taking it down, thus materially reducing the time required for handling the piece to be punched. The arrangement is found particularly useful in safe work, for the angle bars for corners, etc., where there are square, round and oblong holes to be punched.

Both these machines were designed and built by the Long & Allstatter Co., of Hamilton, O., and we are indebted to that company for photographs and particulars concerning them.

COAL CONSUMPTION IN LARGE BUILDINGS.

In our issue of Jan. 5 we published a paper on the Mechanical Plant of a Modern Commercial Building," read by Mr. Wm. H. Bryan, of St. Louis, at the last meeting of the American Society of Mechanical Engineers, together with a discussion upon it by Mr. Geo. Hill, of New York city. From Mr. Bryan's reply, closing the discussion, we abstract the following interesting statements respecting the coal consumption in the building under consideration:

The most important criticism which Mr. Hill makes is, that there seems to be a discrepancy between promise and performance, and that while the test duties are high, the actual results are poor. He mentions a number of buildings in which the consumption of fuel is lower, although they have less efficient apparatus, all of which he submits as an argument against the use of improved apparatus. A moment's consideration, however, will show the impropriety of thus comparing buildings which are used for widely different purposes. In order to make a more equitable comparison, we have looked up the coal consumption of a number of large modern buildings in this city, which are of such a character as to be fairly comparable with the Commerce Realty Co.'s plant. All of them have hydraulic elevators, and non-compound electric light engines. The number of tons of 2,000 lbs. of soft Illinois coal consumed in these buildings per annum for all purposes for each 1,000 cu.ft. of space above ground level, is as follows: 4.40, 2.96, 1.91, 1.88, 1.73, and 0.92, the last being the Commerce Realty Co.'s building. The latter is therefore using only a trifle over half as much coal as the best of the other buildings, and about one-fifth as much as the worst. This proves that the coal consumption is not—as Mr. Hill assumes—large, but on the contrary is very small indeed. For instance, during the month of December, 1898, the average load on the engines was 237.5 HP., of which a little less than 10% was for elevators, and the balance for lighting. This large lighting load is due to the building being a very dark one. For the same month the coal consumption was a trifle under 1,000 lbs. per hour, which includes coal used for banking fires and raising steam in the morning, as well as radiation and all other losses, and the heating of the building when the engines were not running. This consumption of 4 lbs. of inferior coal per I. HP.-hour is certainly a good result, being equivalent to about 3 lbs. of anthracite screenings. It is also equivalent to about 3½ lbs. of our coal per I. HP.-hour, while the engines were in operation. In our opinion, simple engines would have required about 50% more fuel for the same work. During the week from Dec. 19 to 25, a careful log was kept of the electrical load, and it was found to range between 400 and 800 amperes, averaging 615. There is now so much data available as to the economy of compound engines, and electric elevators, that these points should be no longer open to discussion.

ENGINEERING NEWS
AND
AMERICAN RAILWAY JOURNAL.

Entered at the New York Post-Office as Second-Class Matter.
Published every Thursday
at St. Paul Building, 220 Broadway, New York, by
THE ENGINEERING NEWS PUBLISHING COMPANY

GEO. H. FROST, ... PRESIDENT.
D. McN. STAUFFER, ... VICE-PRESIDENT.
CHARLES WHITING BAKER, SECRETARY AND MANAGING EDITOR.
F. P. BURT, ... TREASURER AND BUSINESS MANAGER.

WM. KENT, E. E. R. TRATMAN, M. N. BAKER, CHAS. S. HILL, J. J. SWANN, } ASSOCIATE EDITORS.

A. B. GILBERT, ... ASSISTANT MANAGER.

CHAS. W. REINHARDT, ... CHIEF DRAFTSMAN.

ALFRED E. KORNFELD, New York, F. A. PECKHAM, Chicago, S. B. READ, Boston, } ADVERTISING REPRESENTATIVES.

PUBLICATION OFFICE, 220 BROADWAY, NEW YORK.
CHICAGO OFFICE, 1636 MONADNOCK BLOCK.
BOSTON OFFICE, 299 DEVONSHIRE ST.
LONDON OFFICE, EFFINGHAM HOUSE, 1 ARUNDEL ST., STRAND.

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

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

ADVERTISING RATES: 20 cents per line. Want notices, special rates see page 18. Rates for standing advertisements sent on request. Changes in standing advertisements must be received by Monday afternoon; new advertisements, Tuesday afternoon; transient advertisements by Wednesday noon.

The report of the Connecticut Sewage Disposal Commission, abstracted at some length elsewhere in this issue, is to be most heartily commended as a good piece of work done by public-spirited citizens under rather discouraging circumstances. Stream pollution in Connecticut has been a very serious question for some years past. The State Board of Health has done much good work in studying the subject and doubtless would have done a great deal more had it received anything like the liberal appropriations which have been given to its sister board in Massachusetts. Many of the Connecticut cities and towns, finding themselves hard pressed in the courts by riparian owners on streams they were polluting, and feeling that improved methods of sewage disposal, according to existing information, would cost a great deal more money than they wished to expend, conceived the idea of having a separate commission study the problem of sewage disposal, in the hope of obtaining new light. Doubtless others, both cities and individuals, joined with these perplexed municipalities in demanding a State commission. However strong the demand may have been, the frugal people of Connecticut did not propose to lay out much money in the investigation. So when the act authorizing a sewage commission passed the legislature it carefully provided that the commissioners should serve without pay, except actual expenses incurred, and limited the latter to $1,000 a year. In order to give a wider scope to the investigation, providing any municipal body or bodies wished to foot the bills, the act authorized any town, city or borough to consult the commission, paying the latter all expenses it might incur on that account. That is, the commission was not only to serve the State as a whole, gratis, but also any city, town or borough that might call upon it for services. But the cities, towns and boroughs had mercy, for the most part, on the commission. The commisssion deserves the praise of the State for recognizing its leanings towards economy, since it expended only $800 of the $2,000 allotted to it. But far better than this, the commission made a most admirable report, a report which, like many another made by an unpaid commission, goes far towards justifying the plan of asking public-spirited citizens to do certain kinds of work from a sense of patriotic duty and without any money consideration. In all such cases, however, we believe that ample provision should be made for the expenses attendant on the work in hand, including clerk hire for routine work and a fair amount for any technical or professional advice, which would add to the value of the results obtained. For instance, in this case it is very likely that money might well have been expended for gaging some of the polluted streams, the sewers discharging into them, and possibly the chemical and biological character of the water in the streams. We hope the people of Connecticut will show their appreciation of the work of their commission by taking steps to carry out its recommendations, a reward which the commission would doubtless appreciate more than any other that could be given.

The prospect of passing a Nicaragua Canal bill in the present Congress appears to wane. On Feb. 9, Mr. Cannon, Chairman of the House Committee on Appropriations, announced that at the present rate of Government expenditures the present fiscal year will show an excess of expenditures over receipts amounting to not less than $159,000,000, while many large expenditures, such as the provision for large increase of the navy, the $20,000,000 Philippine indemnity to Spain, the claims of Americans for losses in Cuba during the Spanish war and various other national obligations are still unprovided for. In view of these facts he felt it his duty to oppose large or unusual appropriations for any purpose until revenue from some source was provided to meet the expenditure. He further intimated that all the remaining time during the present session of Congress was needed for the proper consideration of the necessary appropriation bills, and that there was little or no chance that the Nicaragua Canal bill could be passed at the present session. Chairman Hepburn, of the House Committee on Interstate and Foreign Commerce, on Feb. 14, attempted to attach his bill for the construction of the Nicaragua Canal as an amendment or "rider" to the Sundry Civil Appropriation bill, now before the House; but it seems quite doubtful whether the attempt to push through a canal bill in this way will be successful.

The objection raised by Mr. Cannon is certainly deserving of most serious consideration. It is his duty, in the position which he holds, to see that Congress does not order expenditures made for which there are no funds in sight to provide; and his warning that the money to build the canal must be raised either by a new issue of Government bonds, or by an increase in the taxes will certainly not be ignored. The point which appears to be overlooked by all parties in Congress is that it is by no means necessary or even advisable at the present session of Congress to appropriate funds for the actual construction of the canal. Negotiations with Nicaragua and Costa Rica to obtain right of way must precede actual construction in any event; and the making of detail locating surveys, and estimates and plans for structures, working plant, etc., must also be done before the actual letting of contracts can profitably begin. In other words, if the present Congress will appropriate even a half-million dollars and provide for the prosecution of this preparatory work under the direction of a competent commission, it will have done everything and more to hasten the completion of the canal that it would do should it enact the Morgan or the Hepburn bill.

The address of Sir Wm. Crookes on the coming exhaustion of the world's wheat supply, reprinted in abstract in our last issue, ranks as one of the most important papers read before a scientific society for many years. The purpose of the distinguished scientist was to show that within a generation the civilized world will be face to face with a scarcity in the greatest of food staples, wheat. His statement that the United States, now the greatest wheat exporting country in the world, will within three decades increase its own demands to such an extent that it will have no surplus of wheat left for export, has been attacked by a host of critics in this country. Mr. Edward Atkinson, notably, has in his usual sanguine manner declared that our production of wheat is capable of enormous expansion. But now comes a most able contributor to the discussion, Mr. John Hyde, Statistician of the Department of Agriculture, and declares, in a paper in the current "North American Review," that Sir William's statement that no very great expansion of the United States' wheat production is possible under present conditions, is substantially correct. Of course the more intensive farming which will follow a higher average price for wheat will have an effect in stimulating cultivation of the cereal in the older and more settled portions of the country, but it is certainly true that there is no more good wheat producing land in the United States still awaiting settlement and cultivation. In fact there is nowhere in the world any such vast tract of fertile land to add to the world's wheat producing area as the great plains of the upper Mississippi valley, which came under cultivation in the years from 1860 to 1890.

We are inclined to believe that the truth lies between the extremes which have been taken by different contributors to this discussion. It is probably true that the low average price of wheat which has continued during the last quarter of the present century will never again be repeated for a similar length of time. There will be fluctuations, of course, but the fact that consumption is increasing faster than production is bound to have its effect in raising the normal price level, and this increase will go on until on the one hand consumption is reduced by the turning of the poorest class of consumers to some cheaper cereal, and until, on the other hand, the increased production due to the stimulus of a higher price will suffice to supply the reduced demand. What this increased price level may be, not even the wisest can say; but it seems altogether probable that "dollar wheat" will in the not distant future represent the minimum of the wheat raiser's return from his crop.

We have become somewhat accustomed during the past two decades to regard farm products as the least salable of commodities. Hardly a product of the soil is there that has not at one time or another during the past few years been literally a drug on the market, and hardly salable at any price. We are approaching the end, however, of this state of affairs. There are no more virgin continents in the temperate zone to conquer and possess, and the pressure of population upon the means of subsistence, which the economists have put to one side during the past half century, must eventually become a subject for serious consideration. The effect of this changed condition bids fair to be felt in a hundred ways that cannot now be foreseen. A new impetus may be given to the growth of rural and village population and a check to the rapid growth of cities. Farming lands, which have long been the most unsalable of real estate, may again be in demand, while city properties may take on more modest value.

Greater cost of foods may make the pressure upon wage-workers so great as to precipitate important social changes that cannot now be foreseen. The effect of all these things upon the course of engineering and industrial enterprises cannot be foretold; but the fact that great changes are likely to come and that we cannot certainly judge the future by the immediate past is one of great significance.

MUNICIPAL CO-OPERATION A POSSIBLE SUBSTITUTE FOR CONSOLIDATION.

In the commercial rivalry between modern cities the desire to excel in size plays a most important part. The prefix Greater, originally applied to London to distinguish the metropolis from the old walled city, is coming into common use to describe cities enlarged by the wholesale annexation of outlying districts. Chicago increased its area fourfold some ten years ago and omitted to use the word,

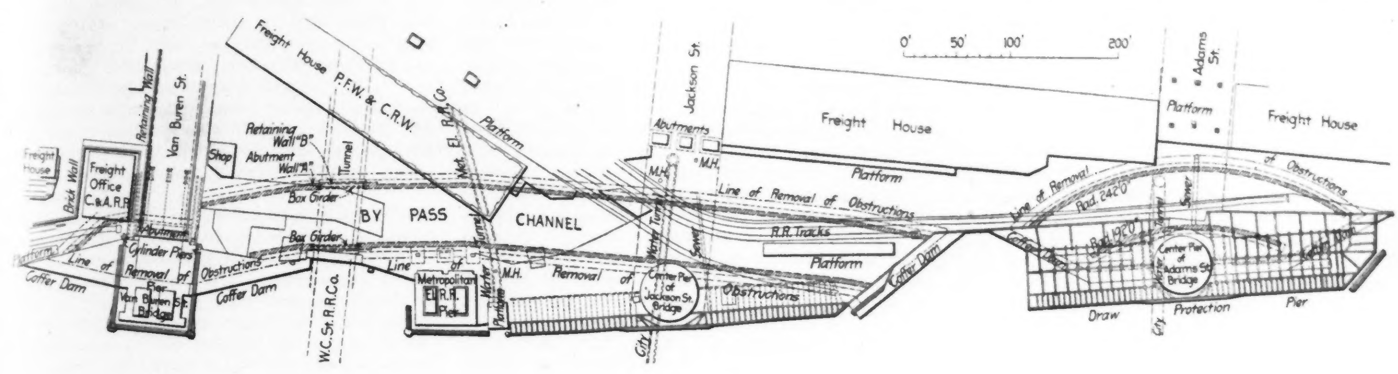


FIG. 1.—GENERAL PLAN OF BY-PASS.

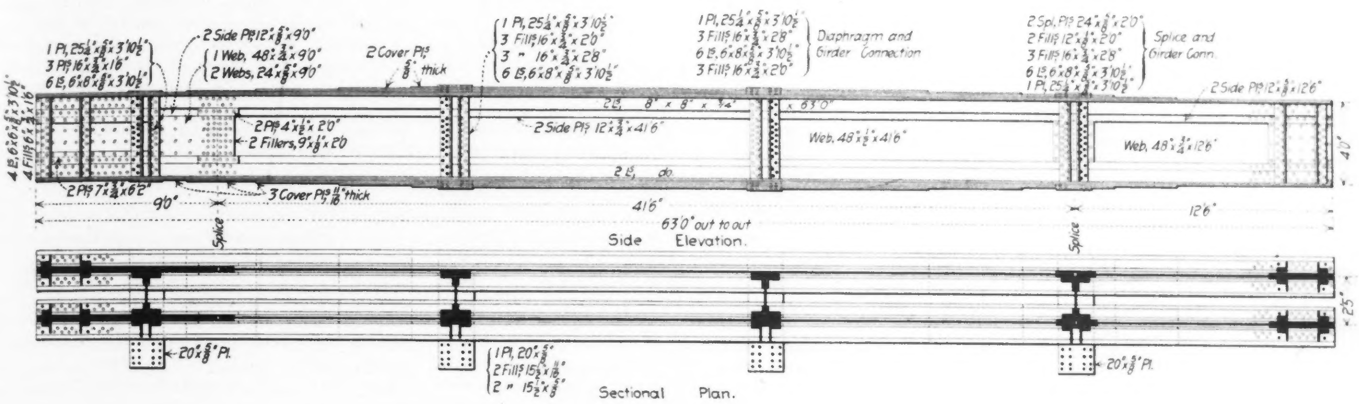


FIG. 4.—BOX GIRDERS SUPPORTING ROOF OF BY-PASS OVER CABLE RAILWAY TUNNEL.

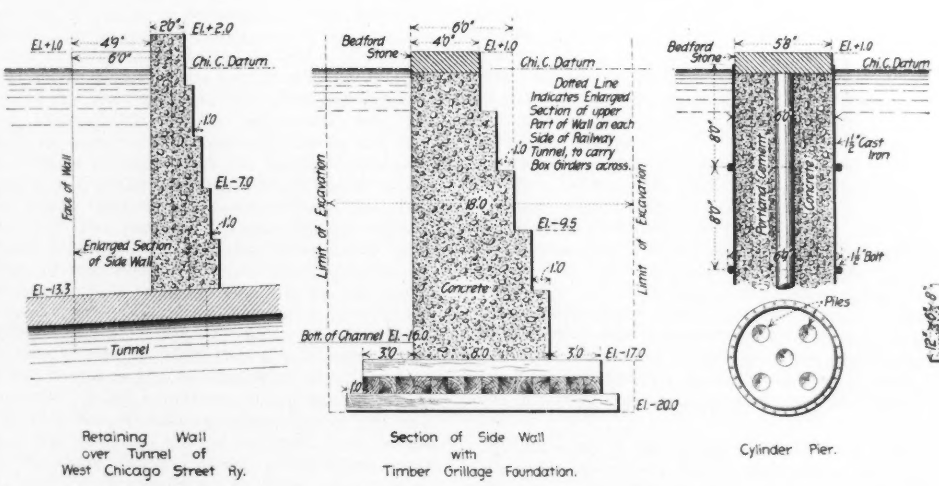


FIG. 2.—SIDE WALLS AND CYLINDER PIERS OF BY-PASS.

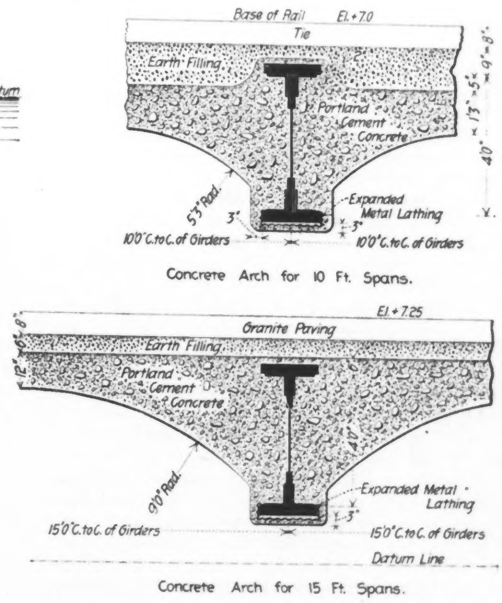


FIG. 5.—CONCRETE ROOF ARCHES.

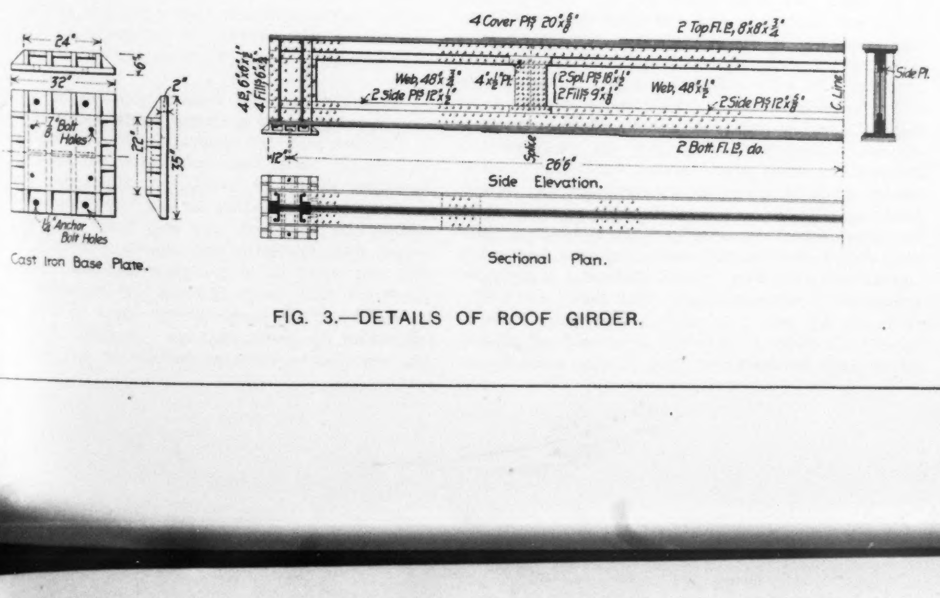


FIG. 3.—DETAILS OF ROOF GIRDER.

BY-PASS CHANNEL FOR THE CHICAGO RIVER.

Isham Randolph, Chief Engineer.

Lydon & Drews Co., and Griffiths & McDermott, Chicago, Contractors.

perhaps because nothing short of the superlative degree will suffice in that breezy city. It remained for the consolidation of New York and Brooklyn and all their outlying suburbs to give wide currency to the term greater to record municipal consolidation on a large scale.

Boston and other cities have recently made use of the word, and just now Greater Newark and Greater Jersey City are current on the tongues and in the press of New York's neighbors across the Hudson River.

The enlargement of municipal boundaries is confined to neither this decade nor country, although in the past ten or fifteen years it has been carried to a far greater extent and conducted in a less reasonable manner here than abroad. Much of this municipal expansion has been a necessary accompaniment of the magical growth of cities. Overflowing populations in the suburbs have been absorbed by the mother city by the force of common interests and real political unity. The extension of city limits in this fashion is in no manner to be deprecated. On the other hand, the extension of the limits of many cities, especially in the West, has been made in advance of the growth of population, purely for the benefit of real estate speculations in tracts outside of the city limits. The extensions of streets, sidewalks, water mains, etc., which have frequently accompanied such ill-advised expansion, have saddled the taxpayers of many cities with a load of debt for which they are receiving no corresponding return.

In the present discussion, however, we propose to consider municipal expansion of another sort,—that of which the Greater New York consolidation is a type. What are the advantages in joining under one municipal government the chief city at a center of population and the outlying independent municipalities which have grown up around it and have developed to a greater or less extent their own distinctive character and population?

We have already alluded to the desire of a city to excel its rivals in size as being a factor in the present craze for municipal expansion. It deserves a word or two more. The claim is that a city derives a direct material benefit from the mere fact that it has more inhabitants than its competitors. Large centers of population do certainly attract investors and residents; but is it not the case that it is the population in a given district and not the number under one municipal government that constitutes the attractive feature? Again, has not the advantage of mere figures to a city been overestimated in the popular mind? Is it not a relic of the real estate boom period in the '80's, which deserves to be cast aside at the present time? The fact that census figures show a certain growth may influence speculative purchases of real estate; but are these weighed by the manufacturer looking for a site for his works or by the home seeker looking for a city for attractive residence? We showed in an editorial in our issue of Feb. 10, 1898, that a well-defined centripetal tendency has developed in manufacturing industries. Many a manufacturing establishment within the past decade has abandoned a site in a large city and has moved to some site in the country where land was cheap, where works could be planned with abundance of room, where workmen could live comfortably at a small part of the cost of life in a city tenement house, and where in consequence a better and more respectable and intelligent class of workmen could be secured. From this point of view, it can be readily seen how idle is the hope that manufacturing industries will be attracted to a great city merely because of its absorption of the cities lying adjacent to it.

There is another reason for consolidation of adjacent cities which deserves much greater consideration than the argument for mere swelling of the figures for population and area. There are certain municipal functions, in which adjacent cities cannot well act in entire independence of each other. Such are the provision for public water supply, drainage and sewerage, and transportation facilities, including in the latter not only street railways, but general street and boulevard plans and in some special cases the provision of important bridges. Another class of municipal functions can be carried on more advantageously when the control of the entire center of population is under a single head. Such are the provision of police and fire protection; the design, construction and maintenance of a comprehensive park system, and the supervision and control of private corporations furnishing gas or electric light supplies. A third class of municipal functions are so purely local in their character that each separate locality may properly be left to carry them out in such manner as its inhabitants may prefer. Examples of these are the opening and improvement of streets, the control of schools and libraries, and possibly the matters of excise and public charities.

It is admitted, we think, by every careful student of municipal government that the principle that each locality should be left in control of its own local affairs, so far as it can do so without additional cost, or without interference with the rights of its neighbors, is a most important one; and that the disregard of this principle in some recent instances of municipal expansion is bound to result in widespread harm. On the other hand it must be freely admitted that in many cases the independent action of adjacent municipalities with respect to sewerage, water supply, etc., is practically impossible. How then are these conflicting requirements to be met?

There are good reasons for believing that the best solution to this question that has been found is for separate and independent municipalities to retain their individual independence and to adopt some form of co-operation for such functions as cannot well be discharged independently of each other. What is meant by this and what may be expected from it can best be set forth by describing a number of concrete cases:

To the superficial observer, the 28 or 30 towns and cities within a radius of some ten miles from the State House in Boston offer the most promising field in this country for municipal consolidation on a grand scale. It seems inexplicable to some that these municipalities have not merged their identity in a Greater Boston, and inevitable that they must do so very soon. But, as a matter of fact, it is doubtful whether such a consolidation will take place for years to come, if ever. One of the great reasons for this doubt is the fact that in the past few years three great schemes of municipal co-operation have been undertaken with results which the residents of the several cities and towns refer to with great pride and satisfaction. These, in the order of their inception, are: The Metropolitan Sewerage, Park and Water Systems.

Independent districts, largely but not wholly the same in area, each with separate commissions in charge, were created by the legislature to provide general sewerage, park and water systems for Boston and the surrounding towns. Both natural and economic considerations have made advantageous if not imperative some joint action for supplying these common needs. Communities with less popular intelligence and more reason for distrusting their public officials might have found it difficult to agree on such schemes without actual consolidation and unity of government.

In the case of the cities about Boston, however, public sentiment was in most cases strongly opposed to consolidation. The local town and city organizations dated back scores and in some instances hundreds of years. The people were proud of their respective cities and loath to merge their identity and lose their control of their own local affairs. On the other hand, the need for a comprehensive provision for the whole metropolitan district was recognized in the case of the sewage disposal, the water supply aand the park system alike. As a result the plan of municipal co-operation already outlined was adopted. The manner in which it has been and is being carried out warrants the statement that nowhere in the country are there public works more excellent in design and execution or better suited to the wants of the communities they serve. All this has been done without sacrifice of local autonomy, with less delay and with no more expense than would have resulted if a Greater Boston had done the work.

If it be urged that Massachusetts is an exceptionally progressive State and that its action in public matters is in advance of what can be secured elsewhere, it may be answered that, so far as municipal co-operation is concerned, there are some notable instances of it in New Jersey, which is conservative in many lines of State policy. In Essex County, N. J., Orange, Montclair, and Bloomfield constructed and operate an outlet sewer for the joint use of the three municipalities; East Orange and Newark have still another; and plans have been made for a third, to serve a part of Newark, Irvington, Clinton, Vailsburg and South and West Orange.

Of more significance still is the Essex County Park System, for which $4,000,000 have been voted and some $3,000,000 already expended, in order to provide a comprehensive system of parks and parkways for the whole county. This county has long been noted for its excellent system of macadam roads, some of which have been provided by the county government. A large part of the county has a common source of water supply, served through independent local distributing systems, and the same is true of its gas supply. Its street railways, also, are included in a single great system and in the control of a single corporation. The water supply, outside of the distribution, the gas and the street railways are provided by private corporations, but they are none the less common to a number of towns in the county.

Aside from the experience of Boston and Newark, and their respective suburbs, there are numerous other cases of municipal co-operation, more especially in the provision of bridges and water-works. The former are too common to need citation. Of the latter, the most notable instances are perhaps the sale of water by Providence, Jersey City and Cleveland to adjoining towns. Smaller places have combined to develop joint sources of supply, like Abington and Rockland, in Massachusetts. Instances of from two to a dozen or more municipalities being supplied with water by one private company are numerous, and the same is true of public lighting and street railway service in other cases than those already cited.

The great advantage of municipal co-operation is that it does not interfere at all with the local autonomy of the several communities, but leaves each free to settle purely local questions in its own way, while insuring nuiformity and economy of action in other matters. Large cities are very unwieldy in many respects and their government gravitates with certainty into the hands of a few True municipal greatness is dependent on the interest and participation of the many in municipal affairs and this is far more likely to be secured in the suburbs of our large cities under independent government than as wards of a great city. It is true that there are some economies in consolidation, but where co-operation is practiced duplication of offices and similar expenses may be avoided in all the joint works. For certain administrative purposes there must be about so many officers for a given area in any case, and a street superintendent, for instance, of a suburban town often receives less pay than a deputy-superintendent of an equal area in a great city, owing to the tendency to pay larger salaries for the same work in large cities than in small ones.

One of the most common motives for the enlargement of municipal boundaries is the wish to unite wealthy residential suburbs with the main city. Often these suburbs would not exist were it not for the larger city and there is some show of reason for bringing them into the city limits and making them contribute to the support of the city where most of the residents carry on their business. But equity will seldom demand annexation on this score. If the suburbs share in the public service of the city, through co-operation or otherwise, they bear their part of the expense. The business investments of such suburban residents are in the cities and are taxed there. Where the business interests of the two communities are not identical there is likely to be little or no excuse for consolidation, although co-operation may be highly advantageous.

The most notable and most recent example of municipal consolidation on a large scale is, of course, the formation of Greater New York. Perhaps it is too early to ask whether New York, Brooklyn and the minor places making up the great whole are reaping any advantages from consolidation, but it is fair to inquire whether the brightest promises of the future could not have posts only, and with center stiffeners to see that they were fairly uniform. The failures before the center stiffeners were added were by buckling of the web under compression, afterward by tension.

The fractures in the webs began on the diagonal of the panel, except in two instances, probably caused by local weakness, and generally showed as a short line at right angles with the diagonal.

My models were small, 7½ ins. between end posts and 1, 1¼ and 1⅜ ins. deep. The material was paper, heavy drawing paper for flanges, end posts and stiffeners, and thin paper for webs. The parts were fastened together with glue. They therefore cannot be taken as fairly representative of the actual girders in use, but I believe they do show correctly the lines and character of strains, which was what I desired. I think they show that the action of such a girder in any material is essentially the same as that of a truss, modified, but very little, by the fact that the web members are in a continuous sheet filling the whole panel and securely attached at all sides. From this it follows that the compressive strains as a destructive element are practically eliminated from the web and transferred to the columns formed by the stiffeners, fillers and included web, provided only that the proper proportions for economy and strength are used in the several parts.

My experiments give no reliable quantitative results, owing to the size of models, character of material and general crudity of the operation, they only indicate the true analysis of the strains. Yet it is rather interesting to note that in each set, the breaking load is very nearly in inverse proportion to length of diagonal of panel, and that the first perceptible permanent deflection occurs with very nearly the same strain in the web in each set, calculated from the load, depth of truss and length of diagonal.

The breaking strain calculated in the same manner is also practically uniform, in each set, and about half the ultimate strength of the paper used for the web, indicating a strain at the center of the web of about twice the average for the whole web.

As before stated, these results are curious rather than decisive, but they seem to indicate that by the method employed by Mr. Turner (Eng. News, Dec. 22, 1898), using the material and mode of construction of actual practice and measuring the strains at all points thermo-electrically, it is possible to arrive at results which will enable us to calculate the dimensions of all the parts of a plate girder under the assumed conditions, with the same accuracy as those of a skeleton truss. I hope Mr. Turner may see his way to continuing his experiments to this end.

Yours respectfully, H. T. Beach.

Syracuse, N. Y., Jan. 6, 1899.

Portable Water Filtration Plants for Military Purposes.

Sir: Our army in its passage through Cuba was compelled to draw its water supply from the surface water flowing in creeks. At times these creeks were lined on both sides by camps and were the natural drainage for the ground occupied by the soldiers. The water from these creeks could not under ordinary conditions, much less in that produced by the proximity of the detritus of large bodies of men, be anything but unhealthful, and from this source undoubtedly came the principal diseases of our soldiers; namely, dysentery, typhoid fever and pernicious malaria. These diseases, with their variations, caused approximately 90% of the sickness of the soldiers of our army in Cuba, and were, no doubt, occasioned by the absorption into the system of pathogenic bacteria contained in the drinking water. Should we undertake to furnish pure water to a moving army, there must be taken into consideration the following propositions: (1) That a system designed for such purpose must be capable of readily purifying and rendering potable any class of ordinary creek, river or lake water; (2) that the operation of such a system shall be rapid, and that the construction shall be of such a weight as to be easily and conveniently moved with the army through sometimes almost impassable country; (3) that the construction and operation of the entire system shall be so simple as to be easily operated, and readily repaired, requiring only the simplest intelligence for its manipulation.

In the first place, to purify bacterially waters of all characters and description, there are at present but two methods which would receive any consideration. One is by distillation and the other by filtration. The distillation system, while the results are perfect and the operation simple, requires a tremendous quantity of machinery of the finest quality and most perfect construction for its successful operation, and becomes eliminated from such a proposition as we now herein discuss, by the tremendous weight of material required in such a plant. The method of filtration, however, furnishes an easy and safe plan for the purification of water, by a plant which can be so constructed as to be capable of being separated into small units suitable for moderate-sized bodies of troops, and at the same time is of such a character that these units may be joined together in batteries and form a combined plant of large capacity. The mechanical filters so largely used in the United States consist in general of iron cylinders filled with sand, through which water is forced at rates of flow varying with the quantity of deleterious matter contained in the raw water. These filters, of which there are many upon the market, differ from each other mainly in the method by which the sand is cleansed. Instead of scraping the surface, as is the case with the class of slow sand filters, at intervals of some weeks, in the mechanical filters the whole body of sand is washed in the filter itself at short intervals, depending upon the rapidity of the clogging. So far as purification is concerned, the principles of these various mechanical filters are identical with each other and with those governing the action of slow filters. The addition of a small quantity of alum or sulphate of alumina to water before filtration is often used in connection with mechanical filtration and introduces an entirely new factor.

As early as 1831 D'Acre published in the "Annales d'Hygiene Publique" an account of the purification of Nile water in Egypt by adding alum to the water, and afterward filtering it through small household filters. More recently alum has been repeatedly used in connection with slow filters, particularly at Leeuwarden, Groningen and Schiedamm, in Holland, where the water from the rivers, used for public supply, are colored by peaty matter which cannot be removed by simple filtration.

The best preventative of typhoid fever and dysentery, derived from bacteria in impure waters, is to purify the water, and I suggest the following as a thoroughly reliable and practical system by which the desired result may be obtained:

Starting with a regiment as a unit, a water supply corps, consisting of four six-mule teams and drivers, three firemen and three engineers and one officer chosen from the engineer corps for special fitness, would make up the necessary quota of men. On the first wagon would be hauled a pump and boiler, capable of furnishing 40 gallons per minute against a pressure of 200 lbs. per sq. in.

On the second and third wagons would be carried filters, each capable of purifying 20 gallons per minute of any ordinary water from creeks, rivers or lakes.

On the fourth wagon would be carried 1,000 ft. of 2½-in. fire hose and 1,500 ft. of 1½-in. fire hose, capable of withstanding safely an internal pressure of 200 lbs. per sq. in. The 1½-in. pipe would be supplied with short taps every 50 ft. throughout its length. The pump, filter and distribution line would be connected, when used, by couplings, and the pumps and filters would be permanently fixed upon the wagons and when in use would be driven up alongside each other on the bank of the creek or river, forming the supply, coupled up and started while the hose wagon would spread the distribution pipe. The fuel would be wood which can most readily be found on creeks or river banks.

By such a system purified water could be delivered to the kitchen line of a regiment or to a line of trenches within 15 or 20 minutes of the time when the camp had been decided upon. It could be taken up and made ready to move with equal or greater celerity.

Without using anything but the ordinary materials in stock throughout the country the weights of these wagons loaded and ready to move would be as follows, which will be seen to be well within the required limits: Pipe line load complete, 2,500 lbs.; filter load complete, 2,500 lbs.; pump load, 2,775 lbs.

Undoubtedly use would develop points which could be improved, and perhaps specially designed apparatus would materially increase the usefulness and availability of such a plant.

The 1,000 ft. of 2½-in. hose is intended to allow the troops to camp at least that distance away from the water course, and on higher and better ground than that close to creeks and rivers. The further away from the source of water supplies the troops are located the less liability of the supply being polluted by them.

All canteens should be filled with the pure water before starting from camp so as to eliminate drinking impure water during the day. This apparatus should travel close to the front of the main body of troops, and the officer in charge be immediately notified of any order to go into camp or rest for an hour or more, so the apparatus could be set up promptly.

Where a greater number of troops than a regiment is to be supplied, the 2½-in. pipe lines of a number of regiments could be connected and the pumps and filters used in a battery, allowing greater distance from the water supply for the troops if the camp were to be maintained for more than one night.

By the introduction of this system, which is light, strong, simple and effective, the writer firmly believes the health of our soldiers would best be sustained, and diarrhœa, dysentery and typhoid fever almost eliminated.

Yours truly, Fremont Hill,
Capt. 2d Regt., U. S. V. Eng.

Camp A. G. Forse, Huntsville, Ala., Dec. 15, 1898.

(There are at least three strong objections to the scheme outlined by Captain Hill: (1) The addition of so much bulk and weight to army baggage; (2) the danger of the whole plant being thrown out of service by the breaking, losing or disorder of some portion of the outfit; (3) the questionable bacterial efficiency of the filters when put into operation under such short notice and under conditions likely to prevail in army life. Inquiries made by us since the preceding sentences were written have resulted in the following: M. I. Ludington, Quartermaster General, U. S. A., informs us that "small field filters of a size to be used by companies, and easily transported, were issued where desired," during the Cuban war. The Pasteur-Chamberland Filter Co., of Dayton, O., informs us that during last August it furnished 1,000 filters for use in the United States Army, and is working on a second order for 500. The filters are supplemented by a force pump, suction hose and strainer, are readily packed and portable. One is supplied to each company, with one each, in addition, for regimental, brigade and division headquarters. They seem to be much better adapted to army purposes, under the conditions outlined by our correspondent, than the regimental plants which he proposes.—Ed.)

THE REPORT OF THE CONNECTICUT SEWAGE DISPOSAL COMMISSION.

Some two years ago the Connecticut legislature passed a resolution providing for the appointment by the governor of "five suitable persons," to "serve without pay, except for their expenses," to investigate sewage disposal in Connecticut. The commission was to have the "power to summon witnesses before it, with books, papers and maps," and on concluding it was to sumbit a report to the legislature. Any city, borough or town was authorized to obtain advice from the commission regarding sewerage and sewage disposal, the applicant to reimburse the commission for any expenses incurred on its account. Aside from such expenses as these, the commission was authorized to draw upon the State for its expenses an amount not exceeding $1,000 a year.

On Sept. 17, 1897, the governor appointed the commission, as follows: Robt. A. Cairns, C. E., Waterbury; John S Cheney, South Manchester; Edward H. Jenkins, Ph. D., New Haven; John N. Woodruff, M. D., Sherman; Fayette L. Wright, Pomfret Center. Mr. Jenkins was elected Chairman, and Mr. Cairns, Secretary. The report of the commission has just been published. It presents in brief compass an admirable survey of the subject of sewage disposal, with special reference, of course, to the conditions existing in Connecticut. More than half the population of Connecticut is located in its eighteen cities, or 480,000 out of 817,000 people, according to the estimates for 1896. All of these cities have public water supplies, and only one small one (Putnam), is without a sewerage system. Besides the city population there are 22 boroughs, 17 of which have water supplies and eight, something in the way of sewers. In addition, seven towns have a water supply and some sewers, besides which there are 21 other towns with water, but little or no sewerage. Of the 32 places in all which are credited with sewers, only two cities, Meriden and Danbury, and two boroughs, Bristol and Litchfield, purify their sewage. In these four places land treatment is in use. (A fifth land disposal plant for Norfolk is now about ready for use.—Ed.) Not one of the coast cities discharges its sewage directly into the deep waters of Long Island Sound. At New London, New Haven, Bridgeport, South Norwalk, and Stamford the sewage goes into a river, bay or arm of the sea, "where it tarries for no one knows how long and is in some cases an offense."

The effect of emptying sewage into streams or other bodies of water is discussed at length in the report. Regarding disposal in the ocean the report says:

> The ocean is not simply a great sink or cesspool to receive the offscourings of the nations and hide it. Nature has no cesspools.
>
> As soon as sewage meets salt water the clay or mud flocks together and begins to sink. Sea birds gather what food they can from the solid parts of the sewage, and fishes also feed upon it. With the fishes are included all the lower forms of animal life, some of them almost microscopic, which abound in sea water and feed wholly upon the solid matter suspended in it. These all are the ocean scavengers.
>
> But the most dangerous and elusive things in sewage, those which are the hardest to manage in any system of treatment, are the nitrogenous matters, animal and vegetable, which are not suspended, but are dissolved in the water, and are thus beyond the reach of birds or fish or any kind of animal life.

been secured as readily through co-operation. Certainly self-government has well nigh disappeared in all sections outside of New York and Brooklyn. Each of these two cities was large enough and wealthy enough to do for itself nearly everything in the way of public improvements that Greater New York can do, unless it be in the matter of future water supply, which could have been readily provided by co-operation. What the smaller places will secure in return for sinking all individuality and self-government in Greater New York we will not predict. Some of them may have lower tax rates, but for how long? And if so, was it for the interest of the larger cities to take them in? As an offset to all possible advantages we see an immense population, with a great variety of local traditions, interests and conditions struggling under one city charter. The 3,500,000 people now living in Greater New York are exceeded in number by the populations of few States of the Union, and will soon equal the population of the whole United States in 1790. To govern such an aggregation of people under a municipal charter is something never before attempted in a republic. Greater London has many more people, but it is made up of scores of separate local governments, having charge of purely local affairs, with the County Council in charge only of certain interests common to the metropolis, such as the main sewerage system.

It is scarcely known that while much of the agitation for a Greater New York was in progress metropolitan investigation commissions were at work in both London and Boston, and that each recommended a county form of government with the largest possible degree of local anatomy instead of any great scheme of consolidation. Each report* advocated nothing more nor less than an extension of the scope of the county, a form of government long in existence both here and abroad, but which in Massachusetts now has for its chief function the administration of certain branches of justice.

It may be set down as a sound maxim of government never to create a new branch of it when the work in hand can be done equally well by one already in existence. The Massachusetts sewage, park and water commissions were created because the work they were to do was for the benefit of its communities extended over four counties. Further, it was to be prosecuted, primarily, with State funds, these to be paid back eventually by the communities benefited. It was easier to create a sewerage commission than to build up a new county, and this commission being formed and doing good service, the park and water commissions naturally followed. The Massachusetts Metropolitan Commission strongly recommended that the duties of the three commissions named be vested in the proposed new county government, composed of a single body of men directly responsible to the people served, instead of being appointed by the governor, and representing all the common wants of the new metropolitan county. This plan is considered far preferable to ordinary municipal consolidation. The reception of the report indicates that the commission was right in judging that there was no real demand for consolidation. In fact, the people seem so well satisfied with the present conditions that no move for a new county has been made. Inquiries made by the writer during a recent visit to Boston led to the conclusion that the sentiment in favor of consolidation is even weaker now than it was a few years ago.

The county idea may serve well as a supplement to, or in some cases a means of carrying out, municipal co-operation and the combined possibilities of the two may often render any further consolidation unnecessary.

A strong argument in favor of giving increased importance to county organizations is that the minor divisions of many counties are quite incapable of coping with certain interurban services, such as electric street railways.

A number of instances are on record in this country where municipal and county governments are co-extensive in area. This plan of co-operation is now being proposed for Hudson County, N. J., in which Jersey City, Hoboken and smaller towns are located. A similar scheme, or at least the consolidation of Newark and some of the other more important subdivisions of Essex County, N. J., is also under consideration. In many respects the business interests of the smaller municipalities of these two counties are with New York, rather than with Jersey City or Newark, respectively. In Essex County, especially, the common local interests are already so well served by the county government and the co-operative undertakings previously outlined as to leave little to be asked. That little can be done by further work along the same lines, with no sacrifice of local self-government. The ideals of these different towns, while on the whole very high, yet differ greatly. Consolidation with Newark would tend to bring all to the same level, and to a lower rather than to a higher plane, since the rivalry between suburban towns is greater than that between the different wards of a large city.

In conclusion, we may say that the problem of securing honest and efficient city government is already so vast and perplexing, and one which so deeply concerns the well-being of all city residents that further increases in the size of cities, except those due to natural growth, should only be made after most careful consideration. If municipal co-operation can be as successful elsewhere as in Boston, Brookline, Cambridge, and the adjoining cities and towns, and as has been the case in Essex County, N. J., the idea may well be extended, both for its direct worth and as a safeguard against the craze for immense cities, which promise to be big, rather than truly great. It is true that the present is an era of trusts and combinations in the commercial world and it may be urged that city consolidation is but a move in the same direction. Under present political conditions, however, and while civic duties rest so lightly on the shoulders of most urban voters, we may well say, beware of huge municipal trusts!

*See Shaw's "Municipal Government in Great Britain," Appendix III., "The Unification of London," and "Report of the Metropolitan District Commission to the Massachusetts Legislature" (1896).

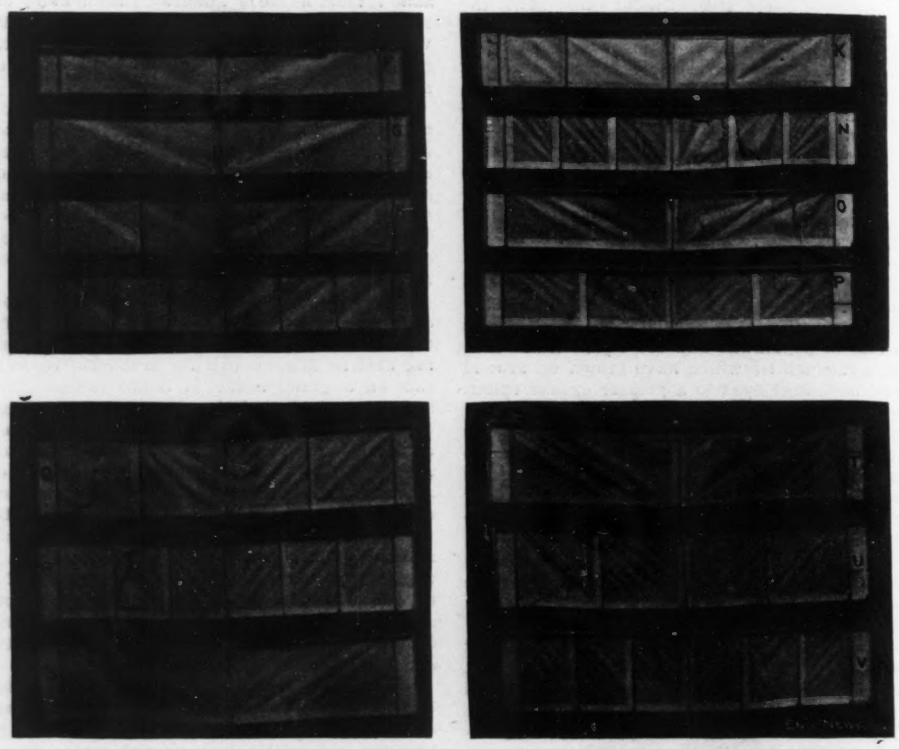
LETTERS TO THE EDITOR.

Spacing Stiffeners in Plate Girders.

Sir: On April 23, 1898, I wrote a letter to you (Eng. News, May 19, 1898) on the subject of spacing stiffeners in plate girders, expressing the opinion that the action of a stiffened plate-girder was similar to that of a Pratt truss. At that time I was not aware that others had considered the subject in the same light, nor had I made any experiments to test practically the accuracy of my reasoning, as I thought such experiments would be beyond my means and facilities. The discussion which followed showed that the idea was not at all new, but had been discussed by others long before I thought of it. Mr. Jos. M. Wilson's experiments with the paper models (Eng. News, Aug. 11, 1898), pointed out an inexpensive and simple way of determining the lines and character of the strains in stiffened plate girders under loads concentrated at panel points. Since the publication of his letter I have spent much of my leisure time in experimenting with such models, the general results of which are shown by the enclosed photographs, which I think need no special explanation.

If, as seemed true to me, the action of the stiffened plate girder is esentially that of a truss, the destructive web strains are tensile and in the general direction of the diagonal of the panel formed by the flanges and stiffeners, and all stiffeners, whether at load points or intermediate, act as posts under compression.

To test this I divided my models into two, four and six panels, varying from four times to two-thirds the depth of girder on rivet lines. The load was applied at each panel point in succession in the earlier experiments, but



VIEWS SHOWING DEFORMATION OF MODEL PLATE GIRDERS WITH DIFFERING SPACING OF STIFFENERS, TESTED WITH LOAD AT CENTER.

later only at the center, as I found that gave the same results as to the points in question, and afforded an easier comparison.

In my tests I first took the reading on the deflection scale without load, then applied gradually increasing loads, reading the scale at each application, and after removing each load. The loads were allowed to stand for a few minutes to show whether the deflection increased during that period. I also noted the first appearance of buckling in the web or other distortion of parts, recording everything for future reference and comparison.

I noticed that the first perceptible buckle in the two-panel models started from the upper, outer angle of the panel, but at some distance from the bottom inner angle, forming a much steeper angle than the diagonal of the panel, as if the strain was carried out by the lower flange acting as a beam, but that as the load increased the angle approached that of the diagonal. I also noticed that as the load increased the buckles became narrower and more numerous, especially in the very thin and flexible webs, this multiplication of buckles and the final break showed plainly that the strain was tensile.

In the four and six-panel models the primary buckles were fully developed in every panel before the secondary buckles appeared in any, starting as in the two-panel models, at the upper outer corner of each panel, multiplying and approaching the direction of the diagonal as before under increased loads. The full development of all the primary buckles showed that the intermediate stiffeners were carrying the load as was assumed on the theory of truss action.

The girders were made in sets of three or six, all alike in each set, except as to spacing of stiffeners, and were tested without stiffeners (as simple I-beams), with end

Wright, Electrical Engineer for the Corporation of Brighton, England. It is shown complete in Fig. 1, which also affords an idea of the interior construction. The cast-iron case, containing what may be termed the working parts, occupies a space about 16½ × 5½ × 3½ ins. The front is provided with a glass window through which the indicating tube and scale can be seen by the customer and inspector.

The principle upon which the instrument is based is quite clearly shown in the sketch, Fig. 2, the actual design and details being shown by Fig. 1. In this it will be seen that a glass tube is bent into a U shape and provided with bulbs at either end (AA). A small indicating tube, (T) is joined to the shorter arm of the U tube just below its bulb. The tube is then nearly filled with a dark-colored solution, containing sulphuric acid, to prevent the filling of the tube with vapor. The tube, as will be seen at the left of Fig. 1, is narrowed down for a considerable portion of its length, the object being to reduce the amount of the liquid as well as to prevent air bubbles from passing from bulb to bulb when the tube is tipped for setting, as explained below. Referring to Fig. 2, it will be seen that the long straight bulb is surrounded by a spiral strip, of special resistance metal (C), which is electrically connected in series with the two binding posts (BB), through the hinges of the movable portion. In instruments of small capacity this spiral band is replaced by a few turns of bare wire, of suitable section, while in the larger instruments the band makes only one straight turn, as will be seen in the center of Fig. 1. With instruments for still heavier currents the resistance or heating coil (C) is composed of strips placed in shunt across the binding posts, which are connected by a suitable resistance.

To install the instrument it is only necessary to fasten it against the wall in some convenient location near the usual wattmeter. One of the main line wires is then cut, one end being clamped into one binding post, and the other end in the second post. The hinged inner portion of the instrument upon which the U tube is mounted is then swung out and the index tube is thus drained of all liquid. It is then swung back, the case closed and

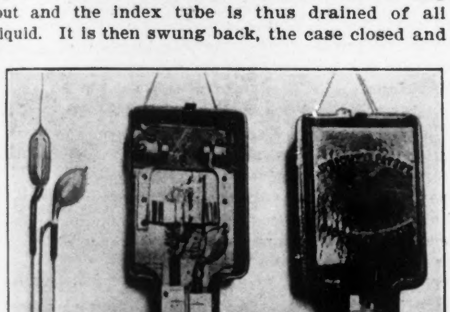


Fig. 1.—An Electric Meter for Determining Customers' Discounts.
The Wright Discount Meter Co., Chicago, Ill.
Mr. J. C. Ulrich, Engineer.

sealed with the usual wire seal and is then ready for use.

The principle of operation is extremely simple, and the instrument may, for the sake of a general understanding, be compared with an ordinary "maximum thermometer." The resistance strip C (Fig. 2) is warmed by the flow of the current and heats the bulb inside it. The greater the current flowing, the larger will be the C^2R or heat loss, and the coil (C) surrounding the air bulb (A) has sufficient resistance to heat perceptibly within the range of the instrument. This heating of the conductor heats the air contained in the bulb, which in turn expands and forces the colored liquid above the normal level (MN), thus causing it to spill over into the index tube in an amount which is proportional to the temperature of the resistance coil (C). It will be seen that the instrument can be so calibrated as to record the maximum current which flows at any time, after it is set, the only condition being that the current must flow an appreciable length of time. That is, if a certain maximum current were flowing for only about five minutes, the meter will register

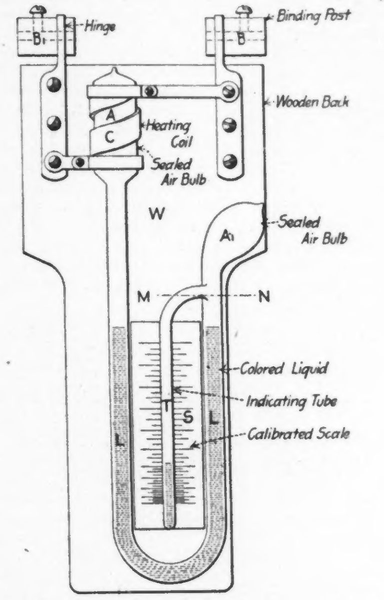


Fig. 2.—Sketch Illustrating the Principle of the Wright Discount Meter.

only 80% of the correct value; for a period of 10 minutes the reading is within 95% of actual, while at the end of half an hour the reading will be practically the full amount. If the index be read at the end of any period, say either a month or a quarter, the reading shows the maximum current that the company has been called upon to furnish during that time. Used in connection with some form of recording wattmeter, both the quantity and the maximum current demanded during the period since the last bill was rendered are in this way known.

At the side of the index tube, and protected from tampering by the glass front, is the scale which might be graduated in a variety of ways, but is, in the actual instrument, marked to show on one side "Kilowatt Hours at Full Rate for winter," and on the other side "Kilowatt Hours at Full Rate for summer," and also a scale showing maximum amperes.

The method of calculating charges can best be shown by figures. Assume a customer on a 110-volt circuit, on whose premises both a watt hour-meter and a discount meter are installed. At the end of a certain month the watt hour-meter indicates 60,000 watt hours (60 K-W hours). The discount meter for the same month gave a maximum of 15 amperes. On the kilowatt hour scale the reading was 49.5 or $\frac{15 \times 110 \times 30}{1000}$ kilowatts.

The 30 being (in the case assumed) the number of hours per month during which full rate is charged.

The full rate, whatever it was, would be charged for this amount and the low or discount rate, whatever might be fixed, for the difference between the total consumption, 60,000 watt hours, and 49,000 watt hours or 10,500 watt hours. In any case, however, the meter's duty is done when it indicates the maximum rate at which the consumer has used current.

For the information and the instruments from which the description accompanying illustrations were prepared we are indebted to Messrs. R. S. Hale and J. S. Codman, Eastern Agents for the Wright Discount Meter Co., 31 Milk St., Boston, Mass.

RAILWAY MAP AND PROFILE RECORDS.*

There is considerable difference in the map and profile records kept in the engineering or maintenance of way offices of different railways, and in this paper I have endeavored to describe the practice in vogue on the Terre Haute & Logansport Railway, with some additional suggestions.

To start with, there should be continuous maps of the entire road, drawn to a suitable scale and made in such a manner that they will form as nearly as possible a permanent record, that is, no temporary information, such as side tracks, station buildings, etc., should be shown. They should, however, show all permanent information, consisting of the company's property lines, railway crossings, sectcion lines (with distances to corners where possible), the mile posts, the alinement, and any intermediate points or stations that may be permanently monumented. In this connection, I consider it advisable to establish a permanent track center about every 1,000 ft. on tangents and at every transit point on curves, as well as to monument the points of curves, tangents and spirals. While public road crossings are of a less permanent nature, it is advisable to show them on these plans, as any new crossing can be added to the plan when opened; and if any crossing is abandoned, the fact can be noted on the plan, giving the date, without making any erasure. These maps should show from whom all right of way is procured, giving the date, the kind of conveyance, and the true dimensions of the property covered by such conveyance, together with a concise statement of any special provisions contained in the deed or grant, regarding, for instance, drainage, fencing, private crossings, etc. These plans in my office are drawn to a scale of 400 ft. to 1 in., except through towns and cities, where a scale of 100 ft. to 1 in. is found necessary to show all the property clearly, together with the statements as above.

Instead of putting a certain length of track on each plan, each sheet is made to contain only one land section, even though the track cuts across only a small corner of the section, except where the 100 ft. scale is used, in which case as much is shown as will conveniently go on the size of sheet adopted. Each sheet has its proper title, giving the section, township and range, or the name of the town or city, as the case may be, and the plans, for convenience, are then bound together in book form in their proper order. The size of these books, or atlases, in use here is 18 × 26 ins., the number of pages in each book varying from 17 to 37. The original atlas should be made on some good, durable paper, such as Whatman's "cold pressed" paper, or egg-shell paper. If a second copy is needed to provide both the office of the Engineer of Maintenance of Way and the Chief Engineer's office, it may be traced from the original copy, and in that case it would be advisable to bind the tracing copy so that any sheet might be readily removed and replaced if a blue print should be wanted.

In addition to these atlases, or permanent plans, there should be a complete set of station plans, drawn to a scale of 100 ft. to the inch, to be used in planning rearrangements of tracks, locating industries, etc. These plans should show fully the correct property lines, the subdivision of the adjacent property, all side tracks, company buildings and platforms, other buildings on company property, driveways, stock pens, water tanks, coal docks, etc., and also all important buildings within the limits of the station plan, whether located on company property or otherwise. This latter will very often save some unnecessary trips over the road. These station plans are, in my opinion, of too permanent a character to make it advisable to show on them property leased to other industries which may extend over only a short term of years. For that reason I believe it would be advisable to file away with the tracing a blue print of the plan made as above showing in addition all the ground covered by leases.

We always make a tracing of legal cap size for each lease made by our company, filing the tracing and attaching a blue print, properly colored, to each copy of the lease. The station plans, so far as convenient, should be of a uniform size, or some multiple of that size.

In addition to the foregoing, there will be a large number of miscellaneous drawings, governing which no fixed rules can be followed, other than that they may conform as nearly as possible to the standard sizes of sheets adopted. In many instances it will be impossible for the sizes to conform to these standards, one instance being the detailed plans of truss bridges. In this case, a complete set of the shop drawings made by the bridge company should be kept on file, which will, of course, be of the bridge company's standard size.

Some sort of a bridge record must be kept in the office, and a book record stating the total length, number of spans, length of spans, height, kind of bridge, size of stringers, etc., of each bridge, may answer the purpose. I think, however, that it is preferable to make a tracing of each bridge or culvert, giving on it all information possible, including the contour of the ground, kind of foundation, etc., these tracings to be kept in a Shipman binder,

*Abstract of a paper by Mr. V. K. Hendricks, Engineer of Maintenance of Way, Terre Haute & Logansport Ry., presented at the annual meeting of the Illinois Society of Engineers and Surveyors, held at Champaign, Ill., Jan. 25 to 27.

The algae and other higher forms of aquatic vegetation cannot live in concentrated sewage, but when it is sufficiently diluted they feed upon its dissolved elements, take them into their structure and assimilate them, thus making them innocuous. It is stated that under suitable conditions the algae can decompose volatile fatty acids, indol, skatol, and other offensive soluble matters of sewage. (Bokorny, Archiv. Hyg., 1894, 20, p. 281, ref. Jahresber. Ag. Chem., XVII, p. 49.)

But the soluble elements of sewage, whether concentrated or diluted, are undoubtedly decomposed and returned to living forms by the agency of bacteria living in the sea. The studies of Russell (Botanical Gazette, 1892, XVII, p. 312, and 1893, XVIII, pp. 411 and 439) indicate that while the microbes of sewage and of fresh water soon perish in sea water, species of bacteria peculiar to the ocean are found at all depths. Thus, in Mediterranean sea water, from surface to bottom, 3,200 feet, bacteria abound in nearly the same proportion at all depths, below the limit of constant temperature, 280 to 4,200 individuals per fluid ounce from 10 to 150 per cubic centimeter. The sea bottom is inhabited by active bacteria in vastly greater numbers than the water. This bacterial life is indigenous there, being different in kind from that of the water above. Now this bacterial life is believed to depend for its existence on the soluble nitrogenous matter in the sea water, taking energy from the polluted matter and breaking it up into simpler and harmless forms.

Much remains to be learned regarding the various forms of marine life in their relation to sewage disposal, but we know enough to convince us that the sea is not a mere diluent of sewage; it is no cesspool. It gathers up the wastes of human life, restores energy to them, and returns them to us clean and wholesome.

"Ever at toil, it brings to loveliness
All ancient wrath and wreck."

Much has been said by some writers of the enormous waste of fertilizing material which is annually poured into the sea in sewage, and attempts are continually made to extract from the filth, which goes to make up sewage, some valuable fertilizer for land. It would be an economy if this could be done without offense or danger to public health, and by suitable arrangements it is possible under some conditions to use sewage directly as a fertilizer, thus cleansing it and securing its fertilizing elements at the same time. But it needs also to be remembered that fertilizers poured into the sea are not forever wasted; that to a large extent — we cannot judge how large at present — they are again converted into human food, in part directly, without the intervention of vegetation, and are given back to us by our fisheries. Huxley estimated that the annual product of an acre of arable land is the equivalent of one ton of grain or 200 to 300 lbs. of meat or cheese, "while an acre of sea bottom, in the best fishing ground yields a greater weight of fish every week in the year."

Some of the statements regarding sewage disposal at sea are applicable, with or without modifications to suit the different forms of life, to sewage discharged into fresh water. The supply of free oxygen is the essential point in disposal by dilution. "Now water dissolves air," the report states, "and nearly 35% of the dissolved air consists of free oxygen."

Some of the conditions governing the unobjectionable discharge of sewage in running streams are stated in the report as follows:

If the quantity of sewage is relatively small, if the stream is rapid enough to keep its bed scoured and prevent the deposit of solid matter either on the bottom or on the banks, if it does not foul the water supply of any town or city, if the sewage does not make the water unfit for manufacturing uses, if it does not kill the fish in the streams, or taint the air about it, then little or no objection can be raised to the practice.

But to name these things is to catalogue the evils from which a considerable number of communities in this state are already suffering, and from which they will suffer much more until some of our large cities purify their crude sewage before sending it into our inland waters. Our cities are growing all the time, the quantity of sewage discharged into streams is thereby increased, and the practice which twenty years ago may have been unobjectionable has in many cases become unbearable.

An impression has become general that our waterways were designed by nature to carry all our sewage, and that centers of population have a prescriptive right to them for that purpose, but the fact that the riparian owner has a right to the waters of the stream, unpolluted by sewage, seems to have been in some quarters entirely forgotten.

The worst possible effect of discharging sewage into fresh water is the pollution of water and ice supplies. None of the Connecticut rivers are drawn upon for public water supplies below points where they receive sewage in large amounts. The destruction of fish by sewage is often mentioned. Except where gross pollution prevails, or poisonous substances from factory wastes are in the sewage, it seems probable that fish are driven away by sewage, rather than killed, and that sewage does not endanger the lives of persons eating fish taken from polluted water. With shell fish there is much more danger, especially when eaten raw. A sentence from a Report on the Pollution of Rivers, by Henry Talbot (U. S. Comr. Fish and Fisheries, 1898) may be quoted here:

The data are sufficient to clearly establish the point that river pollution is both directly and indirectly most injurious to fish and fisheries by destroying fish and fish eggs, by driving fish away, by interfering with the fishing apparatus, and by killing or impairing the supply of minute animals and plants which are the basis of fish life.

One phase of stream pollution, or its prevention, mentioned by the commission, is somewhat novel, but the idea is a good one, as will be seen from the following:

We believe, too, that clean streams, like clean streets, clean houses, and clean places of amusement, have a great beneficial effect on the general moral and physical tone and well-being of the whole community, quite apart from any direct effect which is recognized by the sanitarian. Physical and moral cleanliness are closely associated, and either one promotes the other.

Aside from the danger to public water supplies there is always the possibility that stream pollution may result in unhealthful emanations that will lower the vital tone of near-by residents, if it has no worse effect.

On the rights of riparian owners the report quotes at length from a court decision in the famous Danbury case where the city was compelled to purify its sewage to prevent injuries to a mill owner through the fouling of his mill pond with sludge and the general pollution of the stream.

The various processes of sewage purification are carefully reviewed in the report, including the so-called English bacteria beds and the septic tank. These last two processes are considered as still being in the experimental stage. The last few pages of the report proper are devoted to the following excellent summary:

All the larger streams in the state are so far polluted as to be non-potable and their waters can never be used for domestic water supply unless filtered through sand. While the largest rivers are not so seriously polluted as to make them a public nuisance, other streams like the Naugatuck, Park River, and the Hockanum have either reached the limit of permissible pollution or have passed it, so that suits are being brought for nuisance and will probably be brought in increasing numbers. The complaints made in these suits are chiefly of deposits of filth in mill ponds, injury to health by noxious odors and resulting damage to land values. The courts have found for the plaintiffs in every case that has come to our knowledge, and have rendered decisions strongly upholding the rights of a single riparian owner as against the convenience and financial interests of a large community.

The evils which result from the present excessive pollution of our streams and harbors are (in addition to the invasion of legal rights of riparian owners) possible contamination of water and of ice supply, destruction of fish, general unsightly appearance of the streams, and damage to the public health.

There are only three methods of sewage disposal which are at all permissible as substitutes for water-carriage and dilution, viz: (1) Chemical Precipitation. (2) Broad Irrigation. (3) Intermittent Filtration.

Of these the first cannot be regarded as in itself complete. It removes all suspended matter and from 30 to 50% of the putrescible matter of sewage and gives a clear or nearly clear effluent which may safely be discharged into streams under some conditions, but under other conditions filtration of the effluent will be necessary.

The second method, Broad Irrigation, requires a relatively large area of land and may profitably be combined in some cases with the third method, Intermittent Filtration.

This third method, properly managed, secures the almost complete destruction of the dangerous organic matters and bacteria of sewage, and having been in successful operation in this climate for a term of years may be regarded as no longer an experiment, but as a well established and most effective method of destroying sewage. Unfortunately, some cities are so situated that their sewage can only be brought to land suitable for filters at very large expense.

In conclusion, the Commission offers the following expression of opinion, based on its study of sewage disposal in this state:

(1). The disposal of sewage without nuisance is a duty which each community owes to the public. It is a problem to be settled by each community for itself, with such state supervision and control as is necessary in the public interest. In some cases, however, several communities, lying in the same topographical district, may profitably unite in the construction and operation of common outfall sewers or of disposal works.

(2) No city, borough, or town, which has not now a sewerage system, should be allowed hereafter to build one which will discharge sewage or polluted water into any stream, whether such stream at the time is used by others for sewage disposal or not, nor should private corporations or individuals be allowed to discharge house sewage or excreta into any streams or rivers.

(3) To insure sewage construction and methods of sewage disposal which will be permanently satisfactory, the General Assembly should not grant to any corporation authority to issue bonds for building, or to condemn land for building, or to build any sewers, or system of sewers, until an accurate topographical survey of the region to be sewered has been made, and together with plans for effective sewage purification before discharging the effluent into any stream, has been submitted to, and approved by, some competent state authority.

(4) Provision should also be made by which cities and boroughs now having sewage disposal works, or which may hereafter build them, may be compelled by the state to so manage them that the sewage shall at all times be effectively purified before its discharge into rivers.

The state is now at the parting of the ways. It may leave the whole matter to drift as it will. Our smaller streams will then become more and more polluted, and at last will be so foul during the summer months that private individuals, plagued beyond endurance, will undertake the expense and wearisome delay of lawsuits, and after years of litigation, it may be, will at last succeed in holding up those cities which have most contributed to the defilement and force them to discontinue it and spend hundreds of thousands of dollars in changing their system of disposal. This is what is going on in this state to-day.

Or the state may take up the matter and seek, without unduly interfering with municipalities or manufacturing industry, to stop further pollution of our streams and reduce the present amount of it in the interest of public comfort and health. Such a policy will need to be framed and executed with great judgment so as always to have behind it the force of public opinion, to be consistent and continuous in its operation, and to be administered with strict impartiality. This course, we believe, the state should adopt.

If this commends itself to the General Assembly, we recommend that an act be passed embodying the points covered by Sections 2, 3, and 4, just given. This will check the increase in the fouling of our streams, and will be an advance in the right direction. We also recommend that the study of sewage disposal in this state be continued by a Sewage Commission. The foregoing report, as already intimated, is of necessity merely preliminary.

There are questions pressing for solution which cannot be immediately answered, but should have careful and intelligent study before any legislative action is taken. Ill-advised legislation, or injunctions of the courts, which will surely follow neglect of these questions by the public, are likely to inflict most serious injury on municipalities and on manufacturing interests. As examples of these questions we may cite the following: Are there any means, the value of which has been proved, by which the suspended matters in sewage may be separated and destroyed, by bacterial or other action, so as to greatly increase the quantitative efficiency of sand filtration, with a proportionately large reduction of the area and expense involved in sewage disposal? A most important question where suitable land is scarce or high in price.

Is it practicable or advisable to classify the rivers of our state, or to divide certain streams into sections, a part of which shall be given over to the carriage of sewage, in quantity not sufficient to create a nuisance, and a part of which shall be protected in every possible way from pollution?

Are there certain topographical sections of the state the inhabitants of which, in the interests of economy and public welfare, should be recommended or required to join in the construction of outfall sewers or disposal fields?

Are there factory wastes now discharged into streams which by proper treatment can be purified, made entirely unobjectionable, and the cost of the treatment largely, if not wholly, met by the value of products recovered from these wastes?

There are three appendices to the report, as follows: Abstracts of reports on sewage disposal at Waterbury and New Britain, by Rudolph Hering and Samuel M. Gray, respectively; and a description of land disposal as actually carried out at Meriden, the latter being illustrated by a sketch plan and three views of the disposal area.

AN ELECTRIC METER FOR INDICATING CUSTOMERS' DISCOUNT.

The accompanying illustrations, Figs. 1 and 2, illustrate the construction of a form of electric current meter designed for use in connection with a system of varying the charge for current according to the demands made by the consumer upon the central power station.

While this form of meter has been in use in England for about five years, it has only recently been introduced into this country on a commercial basis; it is now being used by the Chicago, Boston & Cleveland companies, and also by some 20 or 30 others, including the Cataract Power & Conduit Co., for selling Niagara Power in Buffalo.

The instrument is known as the Wright Discount Meter, after its inventor, Mr. Arthur or other suitable binder, from which they can be readily removed for blue printing. I have started a record of this sort, the standard size of sheets being 12½ × 19 ins. outside, with a 1½-in. border at the left side for binding and a ½-in. border on the other three sides. A blue print copy should be used for references, and a copy furnished to the master carpenter for his use, the original tracings being kept on file.

Another good record which I should recommend, where authority can be obtained to incur the expense, is a set of rough drawings exactly similar to the right of way atlases, except that the scale would be 800 ft. to the inch, drawn on the ordinary letter-sized paper, the width of right of way being to an exaggerated scale of clearness, but the actual width being marked in figures. These drawings would be used for a fence record, and they should show the present adjacent land owners' name, the kind of right of way fence in use, when built, rebuilt or repaired, the character of the adjacent property, that is, whether wooded, planted in grain, pasture land, etc., and any information as to the particular need of a good fence at that point to protect valuable stock. I have never kept such a record as this, but believe it would pay, as all fence repairs could then be arranged to the very best advantage without delay, even at such times as you may be crowded with other work. To be of the greatest value, such a record should be kept strictly up to date; but it would still be of great value if corrected but once a year.

We now come to the profile, and this can be made one of the most useful records in the office. As there has been no thoroughly reliable profile in my office, I am now endeavoring to complete one as fast as circumstances will permit. In obtaining the data for this profile, the remeasurement of the road was made along the east rail throughout, as the correct centers were not accurately established to work from, and the expense of rerunning the center line was not warranted or advisable at the time. This, of course, is not absolutely correct, but is accurate enough for all practical purposes. The greatest difference on any one curve on this division between a measurement along the center line and one along the rail is about 4½ ft., and the greatest aggregate difference at any point is about 6.2 ft., the aggregate difference from Terre Haute, Ind., to St. Joseph, Mich., a distance of 222.4 miles, being about 5.2 ft. To show the actual difference between the center line and rail measurements for various curves, the following table has been prepared, giving the differences for each 100 ft. station:

Curve Degs.	Curve Mins.	Difference per 100 ft.	Curve Degs.	Curve Mins.	Difference per 100 ft.
1	..	.....0.042 ft.	4	30	.....0.189 ft.
1	30	.....0.063 "	5	..	.....0.210 "
2	..	.....0.084 "	5	30	.....0.230 "
2	30	.....0.105 "	6	..	.....0.251 "
3	..	.....0.126 "	8	..	.....0.335 "
3	30	.....0.147 "	12	..	.....0.502 "
4	..	.....0.168 "	16	..	.....0.668 "

If the aim is to make a first-class road, or even to maintain a fair road with the least possible expense, the work should certainly be started with a correct and complete profile. On any road where ballast is being, or to be, put in, or where the grades are to be cut down, temporary bridges replaced by permanent structures, etc., this profile is essential for properly laying out the work so that it may all be in line with the ultimate plan, and that no work shall be wasted by short-sighted changes which can only be remedied later by considerable and unnecessary expenditures. As soon as the profile is completed a permanent grade should be adopted, and a detailed estimate made of the cost of all necessary or advisable improvements. Permanent work should be located to the proper permanent grade, or suitable provision made for reaching this grade in the future, and many other matters should be carefully looked into which can only properly be done by the aid of a complete profile.

After this work is completed, the order in which the improvements should be made can be intelligently determined and a certain amount done each year in such a manner as to obtain the final results with the least amount of unnecessary work. For this purpose a profile should contain all the information possible, of both a temporary and permanent nature. The usual profile scale, which I believe to be generally the most convenient, is 400 ft. to the inch horizontally and 20 ft. to the inch vertically. A fine black line should be used to represent the top of rail, with a light yellow wash below and adjoining it. For the natural surface of the ground, I have always used the original surface of the ground over the center of the track, as near as obtainable, showing it by a fine black line with a light brown wash. However, some prefer to show two ground lines, one on each side of the track, the one being represented by a full and the other by a dotted black line. The high water mark at water courses should be indicated by a blue line with a rather heavy blue wash, and the ordinary water mark by a blue line with a light blue wash. All elevations should by all means be based on sea level datum, as established by the government.

Below the profile proper should appear a complete map of the road in plan, except that the curves should be designated by continuous straight lines of a different color from the tangents, instead of by an offset line or curved line, as is often done, so that the right of way lines can be clearly shown. This plan should show and give the stations of all side tracks, stations, road crossings, bridges, important buildings, water stations, etc., so that at a glance all the conditions at any point can be taken in, and there will be far less danger of overlooking anything in planning work, investigating wrecks or accidents, etc. A profile of this sort, of course, requires platting a good deal of temporary information and more or less constant changes, but the benefits derived from it will much more than repay the company for the cost of maintaining such a record accurately.

For the use of the train despatcher, primarily, and incidentally for various other purposes, a detour map, and a condensed profile showing the location of water and coaling stations, passing tracks, car capacities of other station tracks, and the rating of engines over the various grades, make very convenient records. The detour map should not only show the direction of all connecting "Y" tracks within its scope, but also show all distances between all connecting lines, the location of all water tanks, the ruling grades between each connection, and the weight of engines safe to run over each stretch of track. The condensed profile might also be arranged to show the arrangements of tracks at each station, the location, size and style of all bridges, and the alinement.

It may be well here to call attention to the value of using always some standard colors for drawings and profiles to designate the various tracks, etc. The standard colors in use here are as follows:

Existing tracks ....A full yellow line.
Proposed tracks...........................A full red line.
Tracks taken up, or proposed to be taken up.........
......A dotted yellow line or a notation to that effect.
Existing right of way lines.........................
.................A fine black line with a yellow wash.
Proposed right of way lines ....
....................A fine black line with a red wash.
Ground covered by lease.............................
..................A fine black line with a green wash.
Foreign railway tracks...Other colors than yellow or red.
All other lines...................................Black.

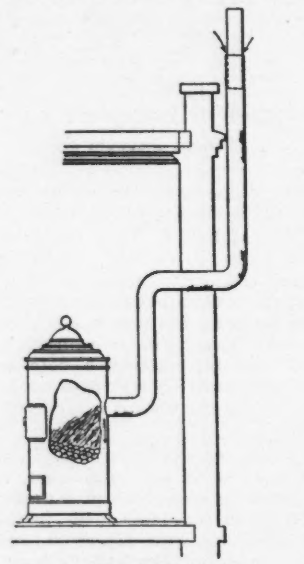


Fig. 1.—The Schlicht Process Applied to a House Stove.

By the use of standard colors anyone understanding them can take in the whole situation at a glance. In adopting standard colors, they should be selected with a view to using the same standard on blue prints.

While the system of records outlined in this paper is a good one, it cannot be advantageously adopted under all circumstances and on all divisions. On an old road, there may be a large amount of accurate and valuable information on hand which is incomplete, but which can be made use of to better advantage by adopting some partially or entirely different standards. On a new road, or where it is found necessary to entirely revise the old records, I do not believe a better system can be adopted than the one outlined; nor do I believe that any road, under any circumstances, should be without a profile made in accordance with the plan suggested.

THE SCHLICHT PROCESS OF COMBUSTION.

We always open our monthly copy of the "Journal of the Franklin Institute" with feelings of respect, when we see on its cover that it has reached "Vol. CXLVI." and its 73d year, and that it is edited by a Publication Committee containing such men as Prof. Arthur Beardsley, C. E.; Prof. Coleman Sellers, E. D., with the assistance of Dr. Wm. H. Wahl, Secretary of the Institute. When leisure permits the further reflection that this ancient society was founded by the great Franklin, and that it has been of incalculable service in educating thousands of Philadelphia's citizens, and in circulating scientific information throughout the world, we look upon its monthly journal with feelings akin to veneration, and open it with the expectation of finding something of value within. Such being our feelings toward the "Journal" our pain is the greater to learn that it has fallen from its high position as an educator of the scientific world, that its publication committee has gone to sleep (in Philadelphia), and that it has published a paper, in the November issue, on "A New Process of Combustion, by Paul J. Schlicht, member of the Institute, which contains some of the worst fallacies and the most glaring misstatements ever seen in a technical journal, on the subject. It appears that the paper was read at a stated meeting of the Institute, held on Sept. 21, at which 92 members and visitors were present, and that it was discussed by Messrs. Outerbridge, Scott, Le Van and the author. The discussion, which might prove to be the antidote to the paper, is not published, but the record of the meeting states that "the paper is reserved for publication, and the subject was referred for investigation and report to the Committee on Science and the Arts."

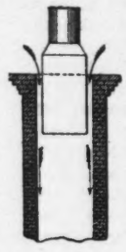


Fig. 2.—The Schlicht Device on a Chimney.

The poison thus circulated by the "Journal" is doing its work, and items concerning the wonderful "Schlicht Process" are appearing in the newspapers throughout the country. The "Iron Age," of Dec. 1, lends its aid to the advertisement of the "process" by publishing Mr. Schlicht's paper almost in full, and even added to it by having a representative visit the plant of the Barber Asphalt Paving Co., in Long Island City, who reported that the superintendent informed him that the introduction of Mr. Schlicht's device had caused a saving of 10 cr 12% in fuel. The "Iron Age" remarks that Mr. Schlicht's paper presents no explanation of the principles underlying his invention, says that "the combustion products and the air travel the same passages in opposite directions" and then leaves the subject "to the consideration of its readers." The "St. Paul Pioneer Press," of Dec. 14, quotes from the "Iron Age" article, suppressing any part that might indicate doubt, and gives it editorial comment, approving it in such words as: "This appears to be the simplest and by far the cheapest device invented for the accomplishment of these objects" (preventing smoke and saving fuel).

The description of the process is very simple. Here it is in the words of Mr. Schlicht's paper:

The invention is based upon the fact, which I have discovered, that if a current of air is properly introduced into a chimney or flue through which hot products of combustion are escaping, the air current will flow in a direction contrary thereto, and, becoming heated in its contact therewith, will reach the sphere of combustion in a condition highly favorable to the union of its oxygen with all the combustible elements of the fuel.

In stoves, house furnaces and other slow combustion ap-

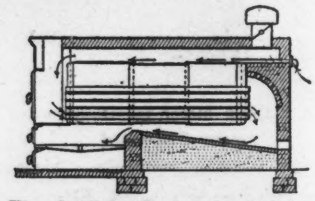


Fig. 3.—The Schlicht Device Applied to a Steam Boiler.

paratus, all of the air for combustion is supplied on the top of the bed of fuel. In industrial furnaces the desired rate of combustion determines the quantity of air to be admitted below the bed of fuel in addition to air supply on top.

In some instances the best results are obtained by closing, or nearly closing the ash pit door. In other instances, when a high rate of combustion is necessary, the resistance offered by the bed of fuel and the air pressure downward through the chimney or flue so reduces the air pressure ordinarily exerted through the open ash pit doors that no appreciably large air supply is furnished upward through the bed of fuel, but it is given a double air supply most favorable to high efficiencies.

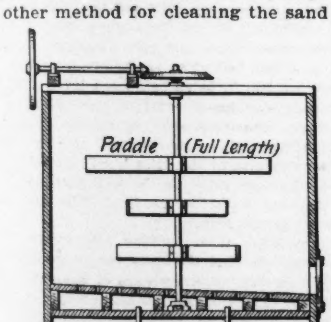
Several cuts are given in the paper as published in the "Journal," some of which we reproduce. Fig. 1 shows the application of a device to a stove. Air is admitted as shown by the arrows in an annular space between the inner surface of the chimney and the outer surface of the extension piece. The ash pit door of the stove is closed, and the cold air falls down the surface of the chimney, becoming heated by the products of combustion which are escaping in the center, and enter the fire from its upper side. Fig. 2 shows the device applied to the top of a brick chimney. Fig. 3 shows its application to a horizontal tubular boiler. In this case the air is not admitted in the chimney itself but in the flue, which covers the boiler, just where it enters the chimney. The course of the air is shown by the arrows leading from the entrance along the top of the boiler, returning through the lower courses of tubes to the back chamber, then downwards and forwards, over the bridge wall into the fire. The accommodating way which this air has of going in just the direction it is desired, just contrary to what would be expected from its ordinary disposition, is especially worthy of notice. Ordinarily, the products of combustion turning from the top of the boiler to go into the flue would give rise to induced currents in any air that might enter at that point. But this particular air slips quietly beneath the gaseous products and goes forward over the boiler while the gases travel in the reverse direction. Then the air has to turn downwards at a right angle to get to the level of the lower rows of tubes, and before it gets to them it has to pass through or around the column of hot gases which is rising from the upper tubes into the flue. The air, after passing through the tubes, has again to pass across or around the rising column of hot gas, but this it does in the most obliging manner. It then flows onward along the floor behind the bridge wall, passes through the contracted passage over the bridge wall notwithstanding the fact that this passage is filled with hot gases moving with high velocity in the opposite direction and gently insinuates itself into the fire. How far along the fire towards the fire door it travels, the arrow leaves to our imagination.

Years ago, when a "tall" story was told it used to be said: "Tell that to the marines, the sailors won't believe it." When an engineering whopper is told shall we have to say: Give that to the "Journal of the Franklin Institute," no other technical paper will swallow it?

A NEW SAND WASHING MACHINE.

By W. H. Roper.*

In concrete work in and about Pittsburg, Pa., engineers have seen the advantage of washing the river or bank sand used. In the construction of U. S. lock No. 3 (all the masonry of which is concrete), at Springdale, Pa., on the Allegheny River, the contractors found it necessary to devise some other method for cleaning the sand dredged



A New Sand Washing Machine.

from the river-bed than the usual one of washing through a revolving screen.

The sand when dredged contains a large percentage of sediment and some coal. In all methods of washing through a wire screen, the percentage of coal is reduced very little, if any, as only the coarser coal with the desirable coarser sand is screened out, while the finer coal with some sediment always remains.

*U. S. Engineer's Office, Pittsburg, Pa.

The accompanying sketch shows the system of sand washing which was finally adopted at Springdale. The essential feature of the method consists in forcing the water up through the sand to overflow at the top. The overflow carries away the sediment and a much larger percentage of the coal and other light material than can be removed by any other method. The tank now used, which has two sloping floors, spaced about 6 ins. apart, is 9 ft. in diameter by 7 ft. deep, and so has a capacity of about 300 bushels. A 7½×5×6-in. pump, with a 3-in. discharge pipe, forces the water into the tank between the floors and up through 1-in. holes in the upper floor. A 7 HP. steam engine turns three agitating paddles fastened to a vertical shaft.

The sand is washed practically free from sediment in from one to two hours. When finished, the water standing on the top is drawn off and the sand is emptied through a door at the side of the tank. The washing costs about one-third of a cent per bushel.

The only improvement over the machine used which I could suggest would be to change the flat bottom to a hopper bottom to facilitate emptying. It is also evident that a larger pump could be used to advantage, increasing the rate of overflow. The machine is the invention of Capt. W. R. Graham, a member of the contracting firm, and a patent has been applied for.

THE PER CAPITA WATER CONSUMPTION OF THIRTY-SIX ENGLISH MUNICIPALITIES.

The accompanying figures relating to the water consumption in English municipalities of upwards of 40,000 population, are respectfully commended to the consideration of Philadelphia, Allegheny and numerous other American cities whose per capita consumption and waste approximate 200 gallons, instead of 20 to 61. They have been kindly furnished to us by Mr. Allen Hazen, Assoc. M. Am. Soc. C. E., who compiled them from a recent report to the London County Council on municipal ownership of water-works in England:

Water Supply Per Capita of 36 English Provincial Cities. (London County Council Report.)

City.	Year.	Population supplied.	Average daily supply, U.S. gallons, Total.	Per capita
Barrow	1897	65,300	2,778,444	42
Birkenhead	1897	102,978	3,200,958	31
Birminghsm	1896	680,140	19,048,767	28
Bolton	1897	250,000	6,600,000	26
Brighton	1897	165,000	7,043,836	43
Bradford	1897	436,260	13,309,200	31
Burnley	1897	104,450	2,750,220	26
Bury	1897	157,500	4,647,530	29
Cardiff	1897	170,000	4,896,000	29
Coventry	1897	60,100	1,730,400	28
Croydon	1897	96,300	3,408,000	35
Derby	1897	111,470	3,027,234	27
Gloucester	1897	43,000	924,000	21
Halifax	1897	217,000	5,184,658	24
Huddersfield	1897	146,930	4,310,632	30
Hull	1896	224,064	10,898,650	49
Ipswich	1897	60,000	1,269,156	21
Leeds	1896	420,000	17,994,046	43
Leicester	1896	220,005	4,752,108	22
Lincoln	1897	51,961	1,465,697	28
Liverpool	1896	790,000	26,672,876	34
Manchester	1897	849,093	34,110,613	40
Middlesborough	1896	187,331	11,388,089	61
Newport	1897	72,362	1,950,000	27
Northampton	1897	70,000	1,620,000	23
Nottingham	1897	272,781	6,506,566	24
Oxford	1897	53,000	1,589,570	30
Plymouth	1897	98,575	5,820,000	59
Reading	1897	71,558	3,008,012	42
St. Helens	1897	85,000	4,200,000	49
Salford	1897	117,081	3,042,049	26
Sheffield	1897	415,000	8,938,994	21
Southampton	1897	76,430	3,451,397	45
Swansea	1897	100,000	3,480,000	35
Wigan	1897	60,000	1,224,000	20
Worcester	1897	45,000	1,932,652	43
Totals and average		7,145,669	238,174,154	33

NEWS FROM THE ANDREE ARCTIC EXPEDITION is reported in a press dispatch from Krasnovarsk, Siberia, under date of Feb. 10. Natives in the Timour Peninsula are said to have discovered on Jan. 7 a cabin constructed of cloth and cordage and the dead bodies of three men. The region is approximately in the direction in which Andree's balloon was drifting when last heard from.

THE AMERICAN CAR & FOUNDRY CO. is the name of a new company incorporated under the laws of New Jersey on Feb. 7, to engage in the manufacture of freight and passenger cars. The capital stock is $60,000,000, made up of $30,000,000 of 7% non-cumulative preferred stock, and $30,000,000 common stock, of which $2,400,000 of each kind will be retained in the treasury to acquire other property or for improvements. The following companies are included in the new corporation: The Michigan-Peninsular Car Co., Detroit; the Jackson & Woodin Mfg. Co., Berwick, Pa.; the Missouri Car & Foundry Co., St. Louis; the Ohio Falls Car Mfg. Co., Jeffersonville, Ind.; the Union Car Co., Buffalo; the St. Charles Car Co., St. Charles, Mo.; the Wells & French Co., Chicago, and the Terre Haute Car & Mfg. Co., Terre Haute, Ind.

FIRE TESTS OF FIREPROOFING in England are to be conducted on an elaborate scale by the British Fire Prevention Committee, which was organized in 1897, shortly after the great Cripplegate fire in London, to promote better methods of fireproof construction, and of fire protection generally. A testing station has been built consisting at present of three houses or furnaces for making fire and water tests of fireproof floors and ceilings. Other houses will be built for testing column fireproofing, etc. As described in the London "Engineer," the existing plant is constructed as follows:

The huts are braced round about 2 ft. 6 ins. from the top, i. e., at the level at which the floor or ceiling under test will be fixed, with ½-in. × 3-in. iron, and they are in addition supported by brick buttresses, two at each corner. The roofs have temporary coverings of galvanized iron. Eventually appliances will be used for dropping weights on floors under test, and in other ways, to imitate as far as possible the state of affairs which will actually exist at a real fire. At present, however, the tests are purely fire and water tests. In order that the temperature of the fire might be regulated to any required degree, it was decided to use gas, and this is prepared on the site in a generator 10 ft. high and 7 ft. 6 ins. in diameter. This is of the ordinary form, having a conical grate, and being fed by means of a sealing hopper from the top. It stands in a concrete tank full of water. Adjacent to this is a small vertical boiler—as a fact, an old fire engine boiler—and steam at 45 lbs. is led from this and is blown by means of a nozzle to the underside of the fire. The gas produced is led through an explosion box into an 18-in. internal diameter main, which is covered with 2 ins. of fireclay and cement. Two 12-in. branches are taken off for each hut, the pipes entering the building through two arches, and there is a valve in each branch. The huts are provided with a brick and gravel floor, up from which project two rows of five pipes, 4-in. internal diameter, to which the gas main is connected. Over these pipes is built up loosely a honeycomb of fire-bricks to the height of some 2 ft. 6 ins., with the object of spreading the flames. There is one doorway in each hut, which, while a test is going on, can be covered with a fireproof door provided with an inspection hole. The air enters under the floor of the hut, and the amount can be regulated by openings just beneath the floor or ceiling under test. The method is somewhat primitive, but apparently successful. Fire bricks, loosely inserted, nearly fill the orifices at the commencement of the test, and as more air is required they are simply hooked out one by one. An ingenious means is provided whereby the temperature inside the huts can be not only taken at any moment, but continuously recorded photographically. The method used is by thermo-junctions and reflecting galvanometers, the type being exactly that used by Sir William Roberts Austen at the Mint. The thermo-junction consists of a pole of pure platinum and a pole consisting of platinum containing 10% of iridium.

The preliminary test of the plant was made on Jan. 31, 1899. The offices of the British Fire Prevention Committee are at 1 Waterloo Place, Pall Mall, London, and Mr. Edwin O. Sachs is Chairman of the Executive Committee.

BOOK REVIEWS.

ROOF FRAMING MADE EASY.—By Owen B. Maginnis, Instructor of Drawing in the New York Trade School. Published by the author. Cloth, 6×9 ins.; pp. 52; illustrated.

This book is a reprint of a series of articles published in "The Carpenter," and it gives a simple, practical method for laying out and framing timber roofs of various forms. Chapters are given on hip and valley roofs and roofs of irregular plan; square, pentagonal and hexagonal pyramidal roofs; conical roofs, circular and elliptical domes, etc., etc. The text is concisely written and the illustrations are profuse and clearly drawn.

KILBURN'S STANDARD HANDBOOK FOR RAILROAD MEN.—By A. Kilburn. Chicago: Laird & Lee. Leather, with flap; 4×6 ins.; pp. 141.

The scope and purpose of this little handbook is explained in the preface as follows:

This volume is intended to help the engine men and train men to become thoroughly intimate with the details of the road service. It gives a perfect and clear description of all the different parts of the engine, of the modern automatic air brakes and their attachments, all illustrated by a complete set of sectional cuts with numbered descriptions. The purpose of each part, the manner of its application and of its working, as also the means of remedying faults and repairing damage, are all set forth in plain language. The author is a railway man speaking to railway men.

The book is gotten up in a satisfactory manner and would seem to be quite useful in its particular field.

QUANTITY SURVEYING.—By J. Lenning. London: E. & F. N. Spon. Cloth; 6×9 ins.; pp. 547; $5.

The taking off or measurement of quantities for estimates in building construction, or quantity surveying, as it is commonly called, is something about which we have very little system in this country. In England, on the contrary, this work has found expression in conventional systems and Board of Trade Rules, and it is the purpose of this book to furnish a guide on all the various bearings of these systems and rules. As such a text book and guide it bears every evidence of being comprehensive and thorough, and although a great deal of its contents have no great usefulness to the American architect and engineer, the book can hardly fail to prove helpful and instructive to any one interested in the subject of which it treats. The book is well printed and made up and has a good index.

A TREATISE ON ROOFS AND BRIDGES.—By Edward A. Bowser, Professor of Mathematics and Engineering in Rutgers College. New York: D. Van Nostrand Co. Cloth; 4¾ x 7¼ ins.; pp. 195; illustrated; $2.25.

This is a text book on the computation of stresses in simple bridge and roof trusses. In his treatise the author says:

The aim has been to explain the principles clearly and concisely, to develop the different methods simply and neatly, and to present the subject in accordance with the methods used in the modern practice of roof and bridge construction. In introducing each new truss, it is first carefully described, and the method of loading it explained. A problem is then given for this truss, and solved to determine the stresses in all the members. This problem is followed by several other similar ones, which are to be solved by the student.

An examination of the book bears out the general accuracy of these statements, and for those who desire a manual of the scope outlined, Prof. Bowser's book will prove, we believe, at least as satisfactory as most textbooks on the statics of bridge and roof trusses.

THE SPEED-LATHE.—PART I. OF ADVANCED METAL WORK.—Lessons on the Speed-Lathe, Engine-Lathe and Planing Machine for the use of Technical Schools, Manual Training Schools and Amateurs; In three parts. By Alfred G. Compton and James H. De Groodt. New York: John Wiley & Sons. First Edition; cloth; 5 x 7½ ins.; pp. 134; $1.50.

This book is made up of a brief description of certain characteristic exercises in wood and brass turning as employed in the mechanical department of the College of the City of New York. In it the endeavor is made, with indifferent success, to bring out the salient principles of speed-lathe work. As stated in the title, the book is one of a series of three on advanced metal work, and is intended for technical schools, manual training schools and amateurs, but we seriously question its value to any technical school worthy of the name, owing to its elementary character and very limited treatment of the subject. The price at which it is offered is excessive for a book of so small size. The illustrations with few exceptions are poor, and in these days of photography and cheap half-tone reproduction, there is small excuse for such poor attempts at perspective cuts as are found in this book.

HANDBOOK OF METALLURGY.—By Dr. Carl Schnabel, Konigl. Preuss. Bergrath, Professor of Metallurgy and Chemical Technology at the Royal Academy of Mines at Clausthal. Translated by Henry Louis, M. A., A. R. S. M., etc., Professor of Mining at the Durham College of Science, Newcastle-upon-Tyne. London: Macmillan & Co., Limited. New York: The Macmillan Co. 2 vols.; 8vo.; cloth; pp. 876 and 732; 927 illustrations; $10.

The translator, in his preface, says that he thinks he is rendering the English metallurgist a distinct service in submitting to him a translation of the most recent and most exhaustive work on the subject in any language. His belief is fully justified. No really good treatise on general metallurgy has appeared in English in over 30 years, and the present work fills a void in technical literature that has long been felt. The object of the work, according to the preface, has been

to give a complete account of the metallurgist treatment of every one of the metals ordinarily employed, together with all the recent improvements in the art, whilst at the same time pointing out the scientific principles underlying each process, and illustrating each by examples drawn from actual practice in various parts of the world.

We regret to find that "every one of the metals" treated of in the work does not include iron, and it is not evident from the preface whether or not a third volume, on iron and steel, is contemplated by the author. A good work on the metallurgy of iron and steel of the same size and written in the same style as that of the volumes before us is greatly needed.

The first volume is devoted to copper, lead, silver and gold, the space given to each being respectively 275, 180, 296 and 124 pages. The second volume treats of zinc, 240 pages; cadmium, 9 pages; mercury, 97 pages; bismuth, 27 pages; tin, 56 pages; antimony, 41 pages; arsenic, 25 pages; nickel, 101 pages; cobalt, 21 pages; platinum, 11 pages; aluminum, 39 pages. There is a very complete geographical index covering 24 pages and a general index of 44 pages.

The style of the author is remarkably clear and concise, and the translation is so well done that it is difficult to find any traces of its German origin. The printing and illustrations are excellent.

PETROLEUM MOTOR-CARS.—By Louis Lockert. New York: D. Van Nostrand Co. 12mo; cloth; pp. 218; 92 illustrations; $1.50.

This work, a translation from the French, is Vol. III of the author's "Treatise on Auto-cars on the Road," the other three volumes being, I, Cycles; II, Steam Motor-cars; IV, Motor-cars worked by electricity, compressed air, carbonic acid, etc. It is a well-written treatise on the present state of the art of building petroleum carriages, including descriptions of the motors, and a discussion of acetylene gas as a possible rival of petroleum for driving motor carriages. Numerous illustrations of motors are given, and their method of operation explained. We quote the following extract, showing the author's view of the present status of the petroleum carriage:

It is no easy task to write on a subject as yet undefined, and which is just in that state of indecision and uncertainty that when we have started we find that we have acquired just sufficient experience about direct combustion motors to enable us to fully recognize their defects, and to feel the necessity for introducing improvements.

It is no exaggeration to say that all of the motors now in use for propelling horseless carriages, there is not one that gives complete satisfaction, or is perfectly adapted for the purpose for which it is intended.

We will, however, describe them, as also the vehicles which they propel; but it is a work that must soon be rewritten, for there is no doubt that in four or five years, or perhaps earlier, almost all the hydro-carburet cars now in use will have disappeared, and will have been replaced by others better suited to the object in view, both as regards the motors, the motion, and the general design.

The present state of auto-locomotion may be compared to an interesting game, played by several players, two very good ones, viz. Steam and Petroleum, and others less formidable, such as Electricity, Compressed Air, etc. Others are pressing forward for places round the green cloth: Liquid Carbonic Acid, and Acetylene, the last-comer, but not the least likely to break the record.

More than two pages are given to a description of the Pennington motor, which a few years ago made a great stir in some newspapers, but which never, so far as we know, was publicly exhibited. The author says:

The Pennington motor, constructed by Mr. Kane, of Chicago, has been highly praised in the American papers, particularly the "American Machinist," but we have no means of judging the value of these eulogies until we see a bicycle fitted with this apparatus, and so far this seems to be a pleasure in store.

The following conclusions of the author in regard to the motor carriage industry are of interest:

Nevertheless, auto-locomotion remains pre-eminently a French industry; the proof thereof is to be found in the very poor results produced by the Americans, in spite of considerable efforts—results so poor that they have not ventured to start a single one of their cars in the run to Marseilles.

It is French both by origin as well as by the relative perfection of the results obtained in our country, where it has certainly achieved the highest degree of development hitherto reached.

But how far is this development, which we describe as "relative perfection," by way of homage to the conscientious efforts of our compatriots, still removed from the mechanical perfection, which must be striven for?

TRAITE THEORIQUE ET PRATIQUE DES MOTEURS A GAZ ET A PETROLE ET DES VOITURES AUTOMOBILES. Par Aime Witz, Ingenieur des Arts et Manufactures, Docteur des Sciences, Professeur a la Faculte Libre des Sciences de Lille. Tome III. Paris: E. Bernard et Cie. 8vo; paper; pp. 600; 214 illustrations.

The first edition of this work, published in 1886, was a small volume of 286 pages. It has now expanded to three large volumes, the first two of which, of 400 pages each, appeared a few years ago; the present volume is devoted chiefly to the progress in the art during the last four years, but contains also a historical review and a treatise on the theory, which makes the book practically complete in itself, and independent of the earlier volumes. To those engineers who read French it may be commended as a most excellent work, superior in some respects to the standard English treatises, and containing more recent information. The chapter on "Automobiles" which occupies over one-fifth of the book, is unique. It contains a history of motor vehicles to date, and full descriptions of leading types.

The first chapter, of 20 pages, is a very concise review of the history of gas engines; then follows a chapter of two pages only, giving a classification and nomenclature. Chapter III., 88 pages, is a "study of combustibles," including illuminating, producer or "poor" gas, gas producers or "gazogenes," water gas, blast-furnace gas, acetylene, petroleum, and the alcohols. Chapter IV., 30 pages, treats of the general theory of gas motors, and discusses briefly the thermodynamics of the gas engine. Chapter V., 26 pages, discusses the experimental theory, giving conclusions in regard to economy derived from actual trials. Chapter VI., 56 pages, gives a very full account of numerous trials of gas and oil motors. Chapter VII., 101 pages, contains illustrated descriptions of the principal gas motors, and Chapter VIII., 40 pages, similarly describes the petroleum motors. Chapter IX., 55 pages, describes the elements of construction of motors. Chapter X., 61 pages, treats of the various applications of motors. Among these are the use of motors in factories, etc., receiving gas from a central station (which the author claims to be the best system of distributing energy), in the raising of water, in electrical stations, in locomotives, hoisting engines and cranes, fire engines and pumps, in navigation and tramways. Chapter XI., 111 pages, is devoted to automobile carriages (les voitures automobiles), and is divided into automobiles, past, present and future; motors and carburetters; mechanism of transmission; and calculation of power. An appendix of six pages treats of recent progress in the utilization of blast furnace gas in gas engines.

The author is an enthusiast on the subject of motor vehicles, and in his discussion sometimes becomes really eloquent. We translate the following extract, which shows that "automobilism" is corrupting the French language as it is the English:

Automobilism is an art, it is a science, it is a trade, it is a passion (it becomes sometimes a mania) which has its enthusiastic apostles. It has its organs of publicity and its press, it has its club, the Automobile Club, founded in 1895, which counts already 1,400 members; it has its vocabulary and its words of its own, of chaffeurs, chaffeuses, of motocycles, of voiturettes, of voiturelles, of petrolettes, of accumobiles, of pilomobiles, of electrobates, even automobiledon, synonym of automedon. The Academy is urged to open its dictionary to all these neologisms; it has its capitalists, and each day sees a new society born for its exploitation.

We are glad to see that the author has not yet given publicity to the latest American word in automobilism, "auto-truck."

CUBA: ITS RESOURCES AND OPPORTUNITIES.—Valuable information for American investors, manufacturers, exporters, importers, lumber and mine operators, wholesale and retail merchants, employment seekers, prospective planters, professional men, sportsmen, travelers, railroad men and others. By Pulaski F. Hyatt, U. S. Consul, Santiago de Cuba, and John T. Hyatt, U. S. Vice-Consul, Santiago de Cuba. New York. J. S. Ogilvie Publishing Co. Cloth, 7¼x5 ins.; pp. 211; 16 full-page illustrations. Cloth, $1.50; heavy paper, 50 cents; by mail postpaid.

In this work the authors treat as fully as personal observation, coupled with the somewhat meagre Spanish data, will permit, of the history, geography and population of the Island of Cuba, its cities and towns, transportation facilities, agricultural, forest and mineral resources, climate, methods of trade, industrial statistics, etc. There is very considerable detail as to Cuban customs and institutions, and the American who would succeed in Cuba is advised to study and duly respect these peculiarities of the people. A large part of the book is devoted to the tobacco, coffee, cocoa, banana and other plantations of the island, and an intelligent idea is given of the methods and cost of cultivation and the probable crop value.

As the Messrs. Hyatt have their official headquarters at Santiago de Cuba, the center of the iron producing region of Cuba, the mineral products of the island naturally receive full consideration. It was not until about 1880 that iron and steel makers awoke to the possibilities of Cuba, and that any attempt was made to develop the rich mineral wealth of the island. The authors claim that for its size Cuba is almost unequalled in its mineral wealth. Iron, copper and manganese mines, of wonderful extent and purity, abound; and considerable deposits of asphalt, quicksilver, zinc, antimony and arsenic, with some gold and silver, are already known. There are salt mines on the north and south coasts, and jaspar, beautiful marbles and royal serpentine are found. The iron mines lie along the southeastern coast, in the Sierra Maestra Mountain range, and 40 groups of mines had been opened and 350 mineral claims were filed before the late revolution commenced. Since 1880 a Pennsylvania syndicate, at the Juragna mines, has built 17 miles of railway and has expended over $6,000,000 in developing the mines and opening communication with the harbor of Santiago de Cuba. In 1891, 330,000 tons of ore were shipped to the United States by this company. The Sigria Iron Co., organized in 1890, has also built eight miles of railway, and shipped 12,000 tons of ore in 1894. The Spanish-American Iron Co. is developing a third group of mines, between Juragna and Sigria, and records a maximum output of 29,000 tons per month, with its shipping point at Daiquiri. This Cuban ore yields from 62 to 68% of iron, of an excellent quality, very free from sulphur and phosphorus. It is easily and cheaply mined in side hill or open cuts; and the labor is chiefly performed by Gallegos, or Spaniards from the Province of Galicia.

Within one hundred miles of Santiago de Cuba, in the same mountain range of Sierra Maestra, there are numerous deposits of excellent manganese ore. An American company, of which Mr. John F. Anderson is the president, has recently purchased the Sabanilla y Marote Railway, and has extended it ten miles to the Ponupo mines. This deposit was uncovered and the first shipment made in 1895, when work was stopped by the insurgents. Copper was mined at Cobre by the natives before Columbus landed on the island; and between 1828 and 1842 the books of the American consulate at Santiago show that the annual shipment of copper from that port alone was worth from $2,000,000 to $3,000,000. The shafts are from 900 to 1,200 ft. deep; all but 300 ft. being below sea level. But in 1867 the mines were abandoned owing to a combination of circumstances not connected with the exhaustion of the ore. Mr. Hyatt believes that these mines, and the numerous other copper deposits in the island, will now be valuable again. He also has great faith in the asphalt and bitumunous deposits in various parts of Cuba, and describes them at considerable length.

The authors warn those seeking employment in Cuba, at the present time, that there are few or no openings for those without capital. A knowledge of Spanish is also indispensible for any situation. While prospective work is abundant, and the cost of living very low, common labor is scarce, as a result of the late war and the abolition of slavery. The American with large projects on hand must, therefore, be prepared to import workmen from Mexico, Central or South America or from the other West Indian islands. There are abundant opportunities for capital everywhere, and one of the first things wanted, says Mr. Hyatt, is the building of the railway link between Santa Clara and Santiago, with spurs to the principal coast towns. He believes that such a line would open up one of the most productive regions in the world, and it would yield fabulous profits under intelligent management. He claims that the absence of this link, more than anything else, finally overthrew Spanish sovereignty on the island, as it prevented the transport and concentration of troops and supplies. A business directory for the chief towns of Cuba, for all trades and professions, concludes this work.

Fe

EN

AN

ENGIN
Subm
Ba
An
(wi
Risk
The
The
Wea
Carr
a
tra
The
mi
Stor
Wat
Ca
Note
Roa
A S
Cl
EDIT
An
Po
EDIT
The
tr

TH
ficati
Chem
the
cedec
inves
8, 18
was
perir
suffic
Loui
bine
231
advi
over
The
per
exp
san
pur
260
exp

T
cap
bef
Bu
one
The
"sh
at
mi
tho
filt

S
Yo
fe
pr
th
of
pu
th
er
of
of

N
b
b
a
i
t
s
i
f
t
h